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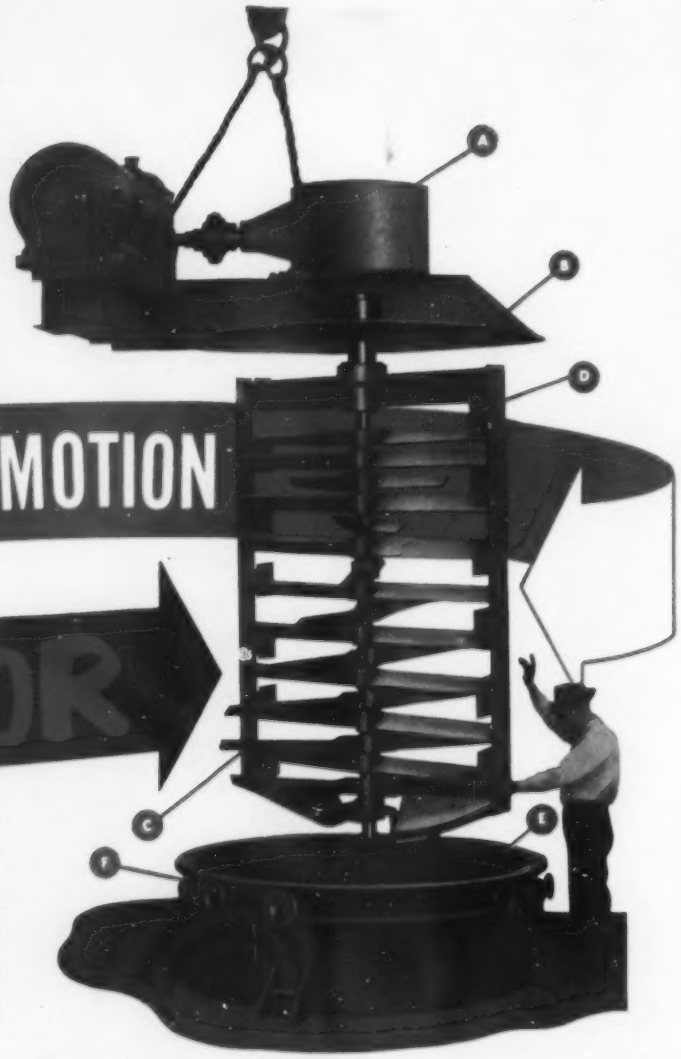

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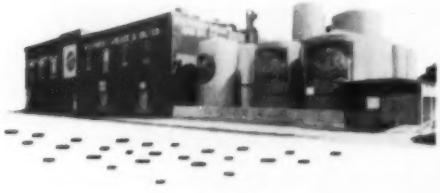

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President's page

by W. M. MURRAY, President, N L G I

COOPERATION IS A KEYNOTE

When your Board of Directors next meets it is to be in Detroit where we will again be privileged to attend the meeting of the Lubrication Committee, API Division of Marketing. Their annual meeting in the Motor City becomes increasingly attractive year after year.

Their speaker program provides what may be termed as inter-industry forum. Representatives of the automotive industry participate in discussions serving all interests of lubrication. Engineering, Service, mechanical and lubricant subjects are all considered and all topics are pointed toward the general target of better lubrication for the motoring public. "Better lubrication" certainly involves lubricating greases and their uses.

The Lubrication Committee has NLGI's congratulations for previous successes and our best wishes for the coming meeting.

The marketing connection is worth comment because the best lubricant in the world, fluid or grease, is of no general value until the product is marketed. The NLGI has well manned, hard working committees planning, and quite effectively, for better consumer recognition of the economical, efficiency and safety features of lubricating greases. The product of this work when properly supported by good merchandising methods will evolve into something of substantial industry value. A reliable and strong prop available to each NLGI member, for helping to focus consumers' attention on the great value of greases, is the individual member company advertising departments. Advertising the merits of individual brand lubricating greases, benefits the entire grease industry. Every lubrication ad may well include definite reference to lubricating grease as an important partner in "better lubrication."

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IN THIS ISSUE

ABOUT THE COVER

Artist Ronald Jones depicts grease fiber dimensions and a wheel bearing tester to illustrate Similarities of Grease Fiber Dimensions in Laboratory Workers and Service appearing on page 18. He combined electron micro-graphs of bulk and surface fibers that had been worked in the tester. The fibers in the micro-graph at left are bulk fibers, and the surface fibers are the small fragments, lower right.

MECHANICAL STABILITY of GREASES In Electric Motors

By E. G. JACKSON and E. R. BOOSER

General Electric Company

As presented at the ASTM Symposium, Technical Committee G, Houston, Texas, February 16, 1955. This was part of the third section, "Technical Considerations of Mechanical Stability."

ABSTRACT

This paper considers the variations in mechanical stability called for by different bearings and some of the bench tests designed to measure these qualities. Results of bench and life tests are compared and the following conclusions drawn. The best open bearing greases are not able to completely withstand severe overpacking. Sealed bearings and large high speed bearings require a channeling grease, and the large bearings need grease-metal adhesion as well. Even when good correlation between life and bench tests is obtained, there are important exceptions. Overpacking of ball bearings in conventional life test equipment may offer one of the best methods for evaluating ball bearing grease stability.

BEARING GREASE LIFE may be the limiting factor in electric motor life; mechanical stability is an important factor in that grease life.

The demands on this stability vary with the type of bearing: open, sealed or large, high speed. Generally, greases performing best in open bearings are not the best in sealed bearings. The difference appears to be due almost solely to special stability requirements for sealed bearings. Large bearings (of the order of 100 mm bore size) are still another special problem with even more stringent demands, judging by the small number of greases that qualify.

The purpose of this paper is to consider the variations called for by different bearings, and some of the bench tests designed to measure these qualities. Results of ASTM worker, Shell roll, and overpacked, open and sealed bearing tests are compared with each other and with life test results in the various types of bearings. While not as many data as desired have been obtained, preliminary conclusions are drawn as to the utility of available test methods and of grease characteristics desirable for the different bearings.

ASTM and Roll Tests

These tests are well known and widely used. Both repeatedly shear the greases being tested, the ASTM worker by forcing it back and forth through orifices, and the roll tester by working it in a combination, sliding-rolling action. In both cases, penetration measurements are used as indices of resistance to breakdown.

Usually, any grease which cannot stand the working in these tests will be potentially subject to severe breakdown in a bearing. Both tests, however, fail to reproduce the high rates of shear which exist between the balls and a cage or between the cage and seals in a bearing running at 1700 rpm or higher. On the other hand, the possibility

of a grease being able to "channel," and so remove itself from further working in a bearing, is not reproduced in either worker. Such variances from operating conditions lead to serious discrepancies when data from either the ASTM worker or the roll test are extrapolated to bearing performance.

Whip Tests

In order to avoid any errors arising from measuring the wrong properties, another test was set up to study mechanical stability in an actual bearing.[1] A standard motor with 306 size, open bearings was modified to include a lock nut and washer on the shaft. The bearings and housings were hand packed 100 per cent full and the motor run for 24 hours. Temperatures during the run were measured and the final grease micropenetrations were compared with the originals.

The sort of data collected is shown in Table I, which includes life test results in open and sealed bearings. The differences between greases are obvious and, generally, those withstanding the "whip" test are found to be better in sealed bearings and large high speed bearings. The better open bearing greases are usually among the poorer by the whip test, perhaps because their higher oil contents and better bleeding characteristics are derived from less rigid gel structures.

Because it directly applies the stresses of ball bearing operation, this test has been used in our laboratory more than the ASTM or Roll tests. Success in terms of corroboration by life tests has been good, as shown by the data in Table I. The one grease that is excellent in sealed bearings in spite of poor whip results is even better in open bearings, which corroborates the test's validity.

Sealed Bearing Grease Retention Tests

Another series of tests was run with 205 size, double sealed bearings at 7200 rpm. They were packed with various greases at various percentage fillings. The temperature was continuously recorded for one hour's run and the weight of grease thrown out during the run was determined. Results with a 70 per cent pack are shown in Table II, along with whip and life test results.

Again there is wide variation between greases, with one long-life grease on the bottom of the list. Life tests were run with a 50 per cent pack, however, and in the retention tests only three greases lost as much as 20 per cent of the original charge when that charge was reduced to 40 per cent of capacity. Greases L, H, O and K were also life tested with an 80 per cent pack in 205 doubled sealed bearings at 8500 rpm. Although K suffered more than the others, the relative standings remained the same, showing that a retention test should be used with caution.

The whip test roughly predicts the tendency of a grease to be "thrown." There are two distinct categories in the whip results and those greases that are badly whipped are also those that throw the most.

Grease Life Tests in Bearings

An attempt was made to correlate data from all these bench tests with results of life tests in ball bearings. The latter tests were of three kinds: open bearing, sealed bearing and large bearing.

The open bearing tests were run with 306 size, the bearings and housings being two-thirds filled with test grease and run to failure at 3600 rpm and 100 C. Five failures were accumulated for calculating a geometric mean life. Sealed bearing tests were run similarly but with a 50 per cent charge of grease between the seals. The large bearings, 130 mm bore size ball and roller bearings, were run at increasing speeds up to 3000 rpm at 60 C, with the grease being examined every 100 hours. If maximum speed was attained with no trouble, the temperature was raised to 100 C and the cycle repeated. Only two greases, so far, have been able to complete this cycle with no evidence of deterioration.

Correlation Analysis

For ten good commercial greases, the available bench and life test data were collected and the greases ranked for each test. Table III shows the ranking obtained.

Using a rank correlation formula, the coefficients of correlation between each column were calculated and arranged as Table IV. A plus signifies positive correlation, a

TABLE I

WHIP TEST RESULTS COMPARED WITH LIFE IN BEARINGS

Grease	Micropenetration Initial	Micropenetration Final	% Increase	Hours Mean Life in No. 306 Bearing at 212 F, 3600 rpm Open Bearing	Hours Mean Life in No. 306 Bearing at 212 F, 3600 rpm Double-Sealed Bearing
COMMON OPEN BEARING GREASES					
A	90	>420	>370	10,000	–
B	66	360	450	8,000	–
C	44	170	290	4,400	1400[a]
D	90	>420	>370	2,000	480[a]
E	55	205	270	–	–
COMMON SEALED BEARING GREASES					
F	85	40	–50	2,000	4600
G	61	130	120	1,900	3200
H	90	40	–55	2,500	2900[a]
I	54	85	60	1,900[b]	2000[b]
J	56	120	110	–	1000
K	74	300	300	>10,000[c]	7500
L	53	54	0	–	>10,000

a. Double shielded
b. 302 F
c. Extrapolated from 250 F test

minus, negative correlation, and a zero, no correlation.

The ASTM and roll tests exhibit positive correlation with open bearing life, and the roll test, negative correlation with sealed bearing life. This is consistent with the negative correlations between open and sealed bearing test results. The whip test is seen to have negative correlation with ASTM and roll tests, yet none with bearing life tests. This anomaly could occur because not all the tests were run on all ten greases, though at least five greases are included in each comparison.

The absence of correlation between the whip and life tests in this treatment is probably because of the go-no go character of the test. That is, the rank of a grease is not so significant as the general anti-whip category into which it falls.

The complete lack of correlation between either the 7200 rpm retention tests or the large bearing tests and any other tests is indicative of the current impossibility of pinning over-all quality to any one factor. For instance, one of the two best greases in sealed life tests was at the bottom of the list in the grease retention test. Apparently, even when 90 per cent of the grease is thrown out in the first hour of running, the remaining 10 per cent is so stable to oxidation that it continues to lubricate satisfactorily for better than average life.

As for large bearings, it had been assumed that the same "channeling" ability so often found in good sealed bearing greases should make for good performance in the 130 mm bore size. When large bearing test equipment was set up, however, it was found that most greases that were excellent in sealed bearings and in the whip test fell down badly in the large bearings. One or more additional factors must be involved in maintaining the mechanical structure in such bearings. It is possible that one extra requirement is adhesiveness. Even a channeling grease may continue to fall into the rolling elements and be churned excessively if it cannot adhere to the race shoulders and housing. The greater mass of grease in the large bearings may be more than most grease-metal interfaces can support.

From some slumping tests run a few years ago, it was learned that greases vary considerably in adhesiveness and that consistency is only one of the factors related to adhesion.[2]

TABLE II

Grease Retention in Overpacked Sealed Bearings

Grease	*Grease Loss, % of Original*	*Whip Test, % Change in Penet.*	*Life in Sealed 306 Bearings at 3600 rpm and 100C, 50% pack, Hours*	*Life in Sealed 205 Bearings at 8500 rpm and 100C, 80% pack, Hours*
I	15	70	—	—
M	20	10	1200	—
N	30	−50	—	—
L	35	0	>10,000	>7000
H	45	−40	3000	1200
D	45	>600	500	—
F	50	−50	4500	—
O	55	800	1800	1100
A	60	>500	—	—
K	90	>600	7500	1500

TABLE III

Relative Ranking of Ten Greases in Various Tests

(Arbitrary rating, with 1 representing the best performance.)

Grease	*ASTM*	*Roll*	*Whip*	*7200*	*Open*	*Seal*	*Large*
A	1	1	10	9	1		3
M	1	1	5	2		6	2
F	4	5	3	7	5	3	1
H	5	4	1	5	4	4	
I			6	1			
L			4	4		1	5
D	3	3	10	6	3	7	4
K			7	10		2	
O			8	8		5	
N			2	3	2		6

TABLE IV

Rank Correlation of Greases in Table III

ASTM	*Roll*	*Whip*	*7200*	*Open*	*Seal*	*Large*
ASTM	+	—	0	+	0	0
	Roll	—	0	+	—	0
		Whip	0	0	0	0
			7200	0	0	0
				Open	—	0
					Seal	0

Conclusions

The conclusions to be drawn from this brief survey are these: (1) Many of the best open bearing greases performance-wise are not sufficiently stable to withstand severe overpacking without some loss of useful life. (2) While most good sealed bearing greases "channel," some very good performers are not of the channeling type. (3) Large bearing greases need something more than just the channeling property to maintain adequate structure. Another necessary factor may be adhesiveness. (4) Even when there appears to be some correlation between grease test results and operation, there are important exceptions and therefore, (5) There is still no mechanical stability bench test giving completely satisfactory correlation with performance. (6) Overpacking of ball bearings in conventional life test equipment may offer one of the best methods for evaluating ball bearing grease stability.

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1. E. G. Jackson and E. R. Booser, "Greases for Electric Motors," NLGI Spokesman, Vol. XVII, No. 12, p. 12 (1954)

2. A. E. Baker, E. G. Jackson and E. R. Booser, "Lubrication Engineering," Vol. 9, p. 250 (1953)

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How Shearing Affects PENETRATION OF GREASES

By R. O'HALLORAN, J. J. KOLFENBACH
and H. L. LELAND
Esso Research and Engineering Company

As presented at the ASTM Symposium, Technical Committee G, Houston, Texas, February 16, 1955. This was part of the third section, "Technical Considerations of Mechanical Stability."

ABSTRACT

Greases differ in their reaction to various types of shearing. The changes in penetration of greases after use in antifriction bearings have been compared to penetration changes effected by Laboratory tests under condition of both high and low shear rates. The results indicate that only laboratory tests employing high shear rates affect the greases as does antifriction bearing service. Simple bearing tests might be best suited to predict penetration changes of grease in bearing use.

Introduction

The penetration of a grease in service is the most important factor affecting its over-all performance. The penetration may change in service due to oxidation, oil evaporation and separation, aeration, temperature changes, and shearing action. This paper deals with penetration changes effected by shearing action encountered in antifriction bearing service.

Summary

Marked changes in penetration of greases in antifriction bearing service have frequently been observed. These changes result from the shearing action of the bearing upon the grease. Laboratory tests operating at low rates of shear fail to indicate even the direction of major penetration changes (whether the grease tends to harden or to soften in use). High shear laboratory tests accurately predict penetration changes which occur in antifriction bearing service. A short-term laboratory test employing a high speed bearing is described which appears satisfactory for predicting such penetration changes.

Test Procedures

Both low shear and high shear laboratory tests were used to measure the effect of shear upon consistency. In addition, simulated service and actual service tests were run to measure the effect of bearing action upon grease consistency. Descriptions of these tests follow.

The low shear laboratory test employed was the grease worker test described in ASTM D-217-52T. This test

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operates at about 10^2 reciprocal seconds rate of shear. The change in penetration after 100,000 double strokes using the fine-hole worker plate was used as a measure of resistance to breakdown from working.

The high shear laboratory test consisted of measuring the change in penetration of a grease resulting from passage through a piston pump which forces grease through spring loaded stallite valves at close clearance.* The pump operates at variable pressures, determined by the clearance in the valve. For this work, the pump was operated at 3,000 psig. The rate of shear at this pressure in the equipment is roughly 10^6 reciprocal seconds. To determine the effect of high shear upon stability, the change in penetration of a grease after five passes through the pump valve setup was measured.

The simulated service tests consisted of running grease lubricated, shielded bearings and determining penetration changes of the grease in use. In one type of simulated service test, a 204 (20 mm.) bearing was packed with two grams of grease and run in the ABEC-NLGI test setup for two hours at room temperature. Tests were run at 10,000 RPM and at 1,760 RPM. Loads were 12.5 pounds radial and 5 pounds thrust. The penetration of the layer of grease on the shield of the bearing after running was measured by a novel technique using a dial micrometer film thickness apparatus. The test procedure is described in Appendix A. Simulated service tests were also run using large size roller bearings. In these tests, a 170 mm. bore roller bearing was operated at 2,500 RPM for 500 hours. Temperatures were about 125°F. during running. Grease samples were removed from various locations in the bearing after the 500-hour run and micro penetrations were determined and results converted to ASTM penetrations. This procedure is described in an article by G. Kaufman, W. O. Finn, and R. J. Harrington, *Ind. Eng. Chem.*, Anal. Ed. v. 11, p. 108 (1939). It requires a 5-gram sample of grease.

The service test consisted of running the grease in a 130 mm. railroad traction motor bearing for a locomotive distance of 200,000 miles. The ASTM penetration of the grease after use was determined.

Test Greases

The greases studied were selected for their differing response to shearing action on the basis of the laboratory tests previously described. Greases A and B are complex sodium soap greases of different soap content. Grease C is a lithium hydroxystearate grease. Grease D is a conventional sodium stearate grease. The compositions are shown in *Table I*.

Test Results

The complex sodium soap greases A and B soften markedly in the grease worker test, but harden on shearing through the pump valve apparatus. The lithium hydroxystearate grease did not change significantly in penetration in either type of test and the sodium stearate grease softened in both tests. Greases A and B are therefore termed shear sensitive greases. Greases C and D are not sensitive to differences in the rate of shear. Data from the laboratory tests are shown in *Table II*. These data indicate that greases which soften under grease worker shearing conditions may actually harden when subjected to high shear. By comparing penetration changes in the laboratory tests with penetration changes observed in bearing service, an indication of the type of forces acting upon greases in bearings can be obtained. It is necessary to use greases sensitive to shear in order to draw significant conclusions. With shear insensitive greases, there would be no significant penetration changes and no conclusions could be drawn as to shearing stresses existing in bearings.

The shear sensitive Greases, A and B, hardened in both the simulated and actual service tests in much the same manner as they had reacted to the high shear tests. The extent of hardening in the simulated service tests varied to some extent, depending upon the speed and size of the bearing. It is noteworthy, however, that in every case these greases hardened in the bearing, rather than softened. The penetration of Grease C was unchanged in bearing tests. Grease D softened markedly in all tests. These data are shown in *Table III*.

*The Gaulin Homogenizer was used in this study to effect the high shearing action on the grease.

TABLE I

Test Greases

Grease	*A*	*B*	*C*	*D*
Type	Complex Sodium	Complex Sodium	Lithium OH-Stearate	Sodium Stearate
Soap, %	27.0	21.3	9.6	15

TABLE II

Laboratory Tests on the Effect of Shear on Grease Consistency

Grease	*A*	*B*	*C*	*D*
Shear Response*	Sens.	Sens.	Insens.	Insens.
Initial Pen., MM./10	295	311	300	240
ΔPen After Worker Test, MM./10	+65	>+89	+5	>+160
ΔPen After Pump-Valve Shear Test, MM./10	−95	−41	−10	+100

*Term "Sensitive" indicates that the direction of major penetration changes on working depends upon the type of shear involved.

TABLE III

Effect of Simulated and Actual Bearing Service on Grease Penetration

Evaluation Test	*Grease* *A*	*B*	*C*	*D*
Original Pen., MM./10	295	311	300	240
ΔPen. After 10,000 rpm Test, MM./10	−85	−36	0	>+110
ΔPen. After 1,760 rpm Test, MM./10	−20	−11	+2	+80
ΔPen. After 170 MM. Bearing Test	...	−81	...	...
ΔPen. After 200,000 Mile Service Test	−100	...	...	...

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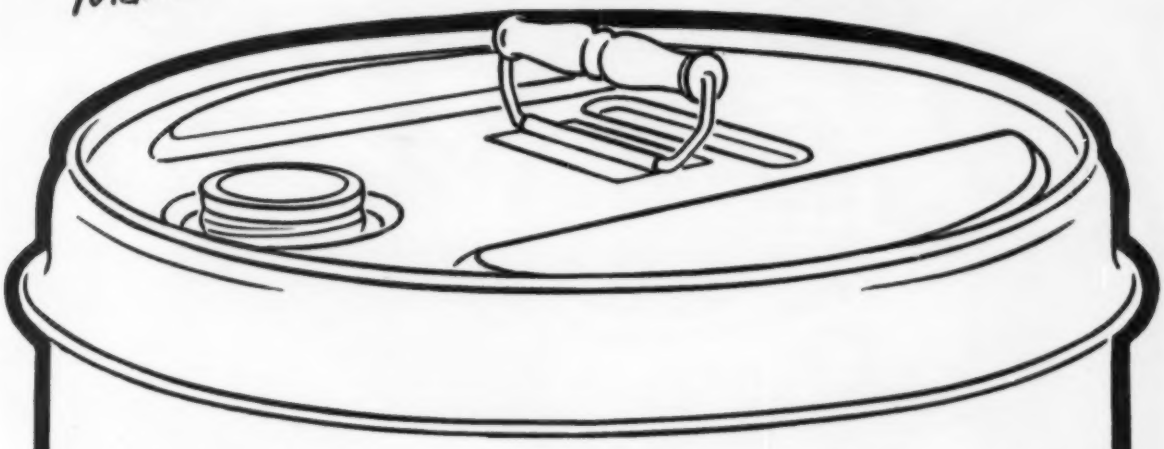

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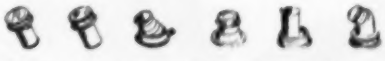

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It is concluded from the data presented in Tables II and III that only a high shear, laboratory screening test will predict the penetration changes which occur in bearing services.

Suggested Test Method

The piston pump test exerts the necessary high shear upon greases and affects their penetration in a manner similar to bearing use. It has shortcomings as a laboratory test method, however. It requires a relatively large sample of grease, and considerable effort and time. It is believed that a simple laboratory test similar to the simulated service test, using the small high speed bearing, could be devised. A simple setup in which a grease lubricated, shielded bearing could be spun on a shaft at high speeds should be sufficient to show, at least directionally, what effect bearing service will have upon grease penetration.

Conclusion

An important factor in laboratory evaluation of grease penetration stability in a bearing is the rate of shear of the test device. The data presented in this article show that high shear tests are necessary to predict penetration changes which occur in bearings. It is believed that a simple laboratory test utilizing small high speed bearings as the high shear test device could be developed.

Appendix

A method for measuring the penetration of grease samples as small as 0.1 gram has been developed using a dial micrometer. This instrument is common in the rubber and plastics field, and measures film thickness in units of 0.001 inch. The dial is attached to a 0.25 inch diameter, flat presser foot, which becomes the "penetrator." *Figure* 1 shows the instrument* being used to measure the penetration of a grease layer on the shield of a bearing.

Figure 1—Penetration Determination Using Dial Micrometer

DIAL MICROMETER GREASE PENETRATION
Correlation with ASTM Method

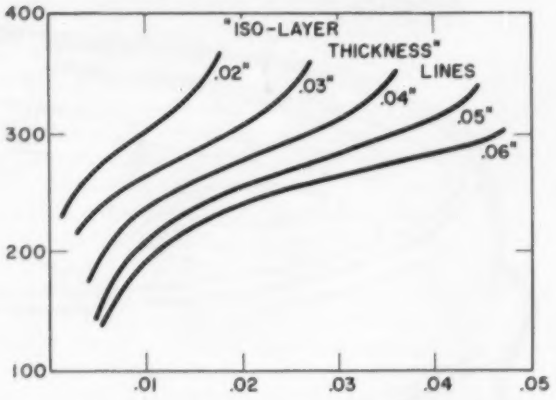


Figure 2—ASTM Penetration, MM./10 Dial Micrometer Penetration, Inches

For grease penetration determinations, two pieces of information are necessary; the depth to which the unweighted presser foot sinks into the grease (after being adjusted to the smooth surface of the sample) in a two-second interval, and the total depth of the grease sample. The total depth is measured by pressing the plunger through the sample to the base plate. The instrument is calibrated with greases of known ASTM penetrations between 150-350 mm./10. These samples should be measured several times each at layer thicknesses from 0.01 inch to 0.10 inch.

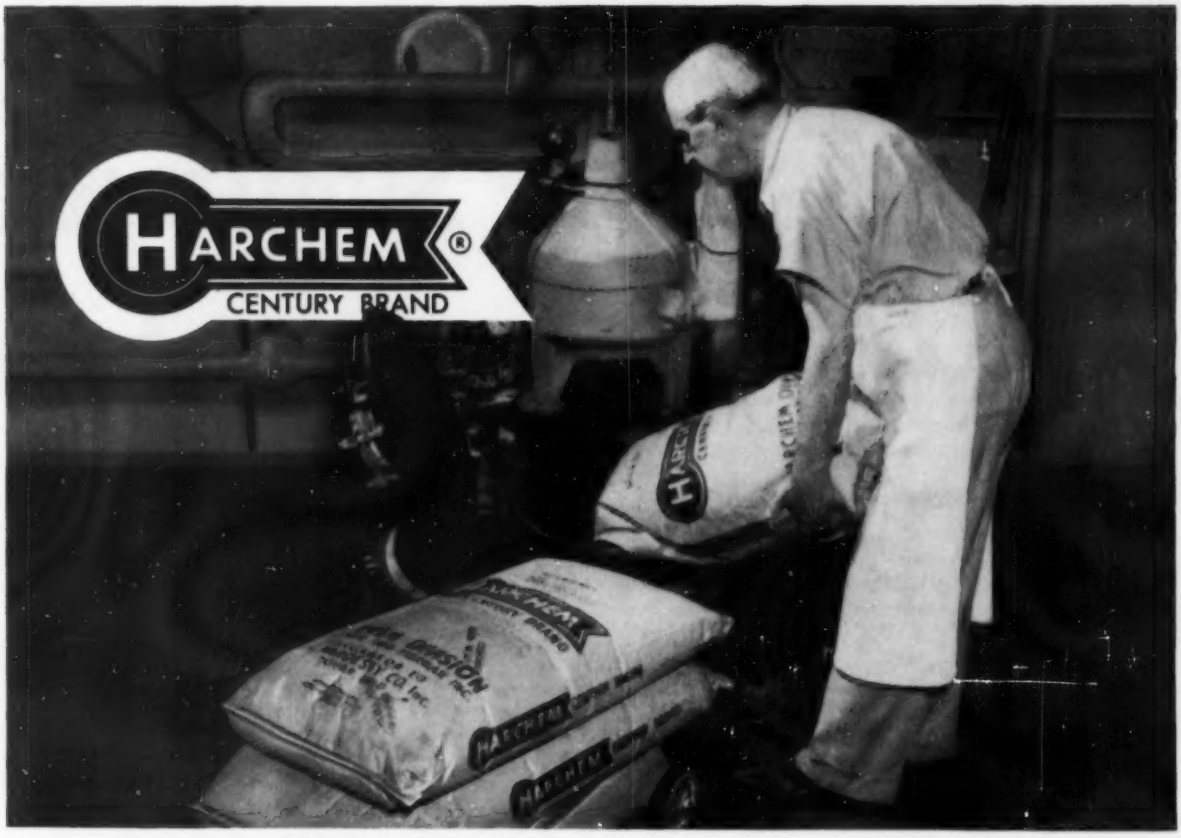
A plot of the two-second drop (in 0.01 inch) versus ASTM penetration (in 0.1 mm.) is drawn up on rectilinear paper, resulting in a family of "iso-layer thickness" lines, as shown in *Figure* 2. Since these curves are flat in the region where the drop is 20-80% of the layer thickness, it is recommended that penetrations be determined in this range if possible. The layer thickness may be controlled by levelling off to a predetermined depth, or the chart interpolated to use values between those shown.

The following example is given to illustrate use of the correlation curve. Assume that a grease sample at two different layer thicknesses was tested with the following results:

At 0.040-inch layer thickness, penetration 0.029 inch.

At 0.030-inch layer thickness, penetration 0.018 inch. Reading off the correlation curve, the ASTM penetration would be estimated at 305 mm./10 for the first determination, and 295 mm./10 for the second determination. The penetration of the sample would be considered as the average of these results, 300 mm./10. In actual practice, several additional runs would be made to determine the penetration more accurately.

*The instrument used in this study is a Randall-Stickney Inspector's Dial Bench Gauge.



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As presented at the ASTM Symposium, Technical Committee G, Houston, Texas, February 16, 1955. This was part of the third section, "Technical Considerations of Mechanical Stability."

Similarities Fiber

ABSTRACT

Differences in fiber dimensions between bulk fibers in laboratory tests and surface fibers in service tests have been used to challenge mechanical-stability tests. To judge the validity of the laboratory tests, the extent of fiber breakage was measured on both bulk and surface samples from the workers and a simulated-service tester. About the same degree of breakage of bulk fibers occurred in all devices, but much smaller fibers were found on the surface. From a fiber-breakage standpoint, laboratory testers should correlate with service, but it is essential to distinguish between bulk and surface breakage.

Introduction

The property most characteristic of lubricating grease is consistency, which is usually measured in terms of penetration. The dimensions of thickener fibers, as determined by electron microscopy, have been correlated with penetration.[1,4]

That a grease must retain consistency during use is a tenet of the industry. The criteria for judging the retention of consistency are varied and empirical. In all mechanical stability tests, changes in consistency are determined by measuring changes in penetration of the bulk grease. In some service tests, consistency changes have been judged by changes in fiber dimensions of the grease on the working surface. Differences in fiber dimensions between bulk fibers in laboratory tests and surface fibers in service tests have been used to challenge mechanical stability tests.[2,3]

There may be large differences between bulk grease and grease close to a moving metal surface. What then is of major significance to grease mechanical stability—bulk changes, surface changes, or both? Before this question can be answered, the changes that occur in both bulk and surface grease fibers in laboratory testers and in service must be compared.

To investigate these changes, samples of a grease were worked in laboratory testers and a simulated-service tester. Both bulk and surface samples were photographed under the electron microscope, and changes in fiber dimensions were measured from the micrographs.

Experimental

Portions of the same grease of NLGI grade 2 were used for all tests. This grease consisted of 7 per cent lithium soap in an oil having a viscosity of 850 SSU at 100°F.

Four devices were used to work the grease: (a) the ASTM worker, (b) the roll stability apparatus, (c) a three-roll mill, and (d) the ASTM wheel bearing tester. The ASTM worker met the D217-52T specifications except that a plate of 1/16" holes was used. The roll stability apparatus was operated at 180 rpm with a 90-g charge of grease. The three-roll mill was a 2½" x 7" mill with three rolls operated at 37, 74, and 148 rpm. The ASTM wheel bearing tester, used as a simulated-service machine, was operated according to D1263-53T, except that a temperature of 77° ± 2°F. was used.

An RCA EMU electron microscope and commercial shadowing apparatus were used in making the electron micrographs.

Concurrent penetration measurements and electron micrographs were made of the bulk grease at several stages of working.[4] Samples were worked for 100,000 strokes in the ASTM worker, 1,000 hours in the roll stability apparatus, and 60 passes through the three-roll mill. Not enough grease could be removed from the wheel bearing tester to obtain a penetration. Therefore, grease was milled for one hour in the three-roll mill with the scraper removed to simulate action in the bearing.

Specimens of surface grease were printed for electron microscopy by contacting part of the wiped working surface to a collodion film. Specimens were printed from the plate edge of the ASTM worker, the center roll of the roll stability apparatus, the center roll of the three-roll mill, and a roller bearing of the wheel bearing tester.

The lengths and widths of the thickener particles were measured and tabulated in terms of average length-to-average width ratios (L/W).[4]

Discussion

Comparisons of changes in penetration and L/W ratio during working in the ASTM worker, roll stability apparatus, and three-roll mill are shown in Fig. 1. Although short periods of working in all three machines hardened the grease, prolonged working softened it to different degrees. The decrease in L/W ratio of the fibers corresponded to the softening.

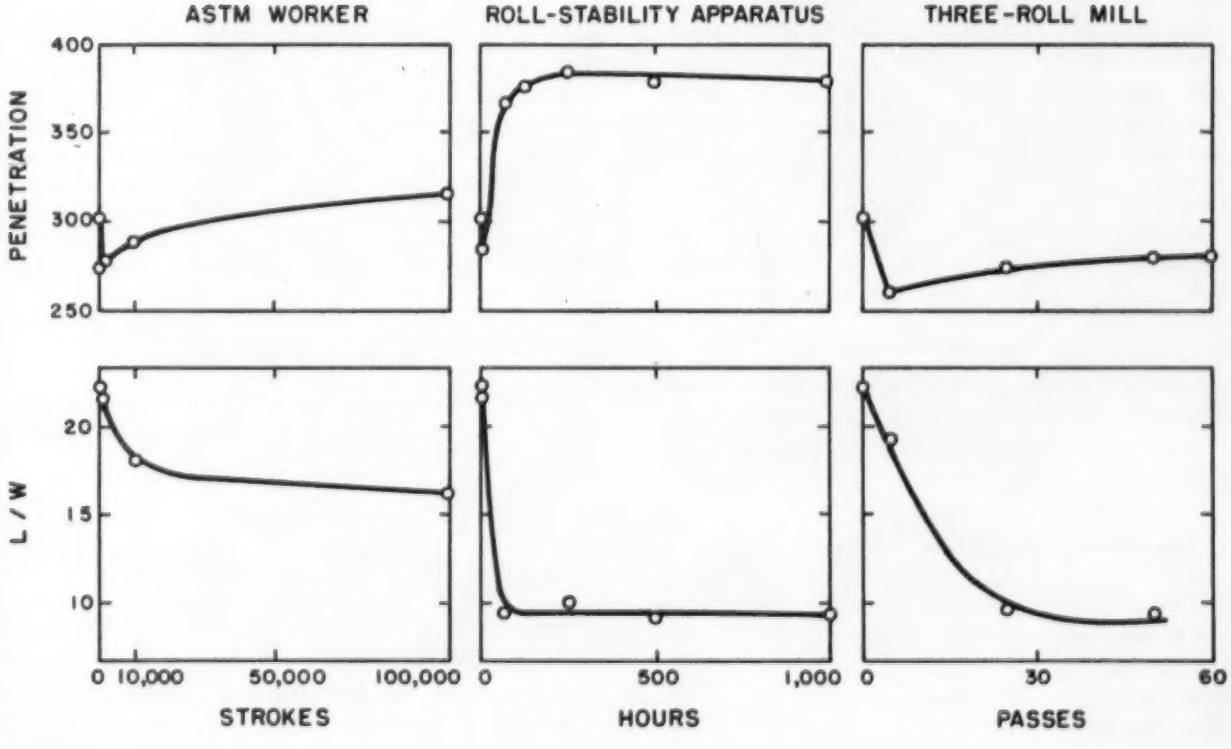
# of Grease-Dimensions in Laboratory Workers and Service

By R. H. LEET, L. C. BRUNSTRUM
and R. S. BARNES

Standard Oil Company (Indiana)

FIGURE 1.

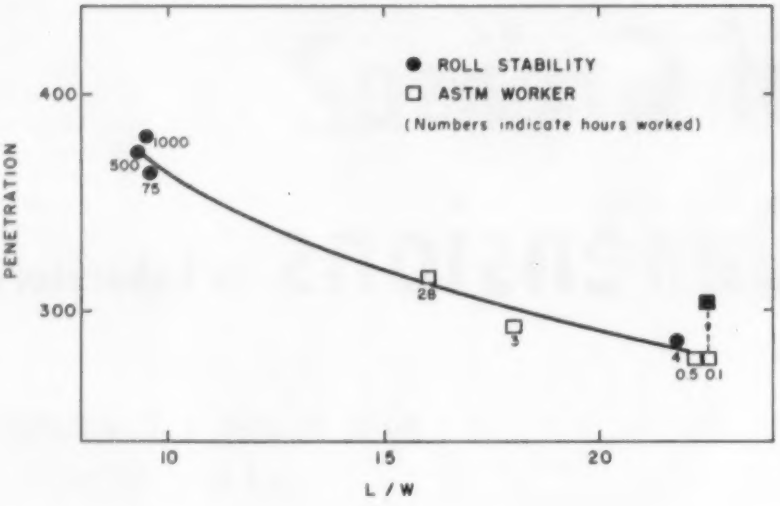
CONSISTENCY CHANGES DURING WORKING



The relationship between L/W ratio and penetration during working in the ASTM worker and the roll stability apparatus is shown in *Figure* 2. Both devices affect penetration and L/W ratio in the same manner, if working is considered in terms of hours. Equilibrium was reached in the roll stability apparatus at about 75 hours, beyond which no large changes in either penetration or L/W ratio occurred.

FIGURE 2

COMPARISON OF LABORATORY TESTERS



The difference in appearance between bulk fibers and surface fibers after working in all four devices is apparent from the electron micrographs shown in *Figure* 3. The bulk fibers are long and only slightly changed by working. The surface fibers are small and appear to be fragments of the larger fibers seen in the bulk grease. L/W ratios of the bulk and surface fibers are given in *Table I*. The L/W ratios of the surface fibers were only 10-30 per cent as large as those of the bulk fibers.

Two possible explanations for the differences between bulk and surface fibers can be suggested: (a) Collision of a soap fiber with a metal surface is probably more severe than collision of two fibers in an oil; to the individual fiber, even the smoothest metal surfaces must seem rough. (b) Fragments broken from the fibers, either at the surface or in the bulk, have exposed polar areas that would be strongly attracted to and collect at the metal surface. Both effects may occur depending upon the type of working and the nature of the metal surface.

The sliding-rolling action of the three-roll mill and the wheel bearing is seemingly quite different from the churning action of the ASTM worker, yet neither greatly changed the dimensions of the bulk fibers. But, on the surfaces of working parts of both, many small fibers were found. There were large differences between the bulk and surface grease fibers independent of the machines used.

Practical Aspects

In service, greases may be subjected to additional softening influences, such as contaminants, excessive temperatures, and over filling. Nevertheless, it seems reasonable to draw a few inferences about bulk and surface conditions in use.

Bulk grease seems to behave as shown by laboratory tests. The shearing action in service must range from practically none in channeled areas to extensive agitation in gear cases or bearings. This action can be duplicated in laboratory testers, although the time required to reach equilibrium penetration varies with the tester.

Less is known about surface conditions. Probably the fibers of any grease are ruptured there and mechanical stability is not a prerequisite for lubrication. There is no evidence that we need information on the consistency of the surface film. Nor are contemplated high-shear testers likely to produce enough grease to measure it. If, in service, appreciable grease transfers between the bulk and surface, the bulk grease would eventually resemble surface grease more than would be indicated by present laboratory testers. The rate of transfer needs to be studied.

TABLE I

Fiber Dimensions of Bulk and Surface Grease

Worker	*Conditions*	*L/W Ratio*	
		Bulk	*Surface*
ASTM Worker	10,000 strokes[a]	18	3
Roll Stability	4 Hours	18	5
Roller Mill	1 Hour	20	2[b]
Wheel Bearing	30 Minutes	21	2[b]

[a]2.8 hours. [b]Estimated.

Acknowledgement

The authors are indebted to W. A. Kimball for the electron microscopy and the development of the mounting technique.

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2. Brown, J. A., Hudson, C. N., and Loring, L. D., *Ibid*, *15*, No. 10, 8 (1952).
3. Forster, E. O., and Kolfenbach, J. J., *Ibid*, *18*, No. 2, 8 (1954).
4. Leet, R. H., *Ibid*, *19*, No. 1, 20 (1955).

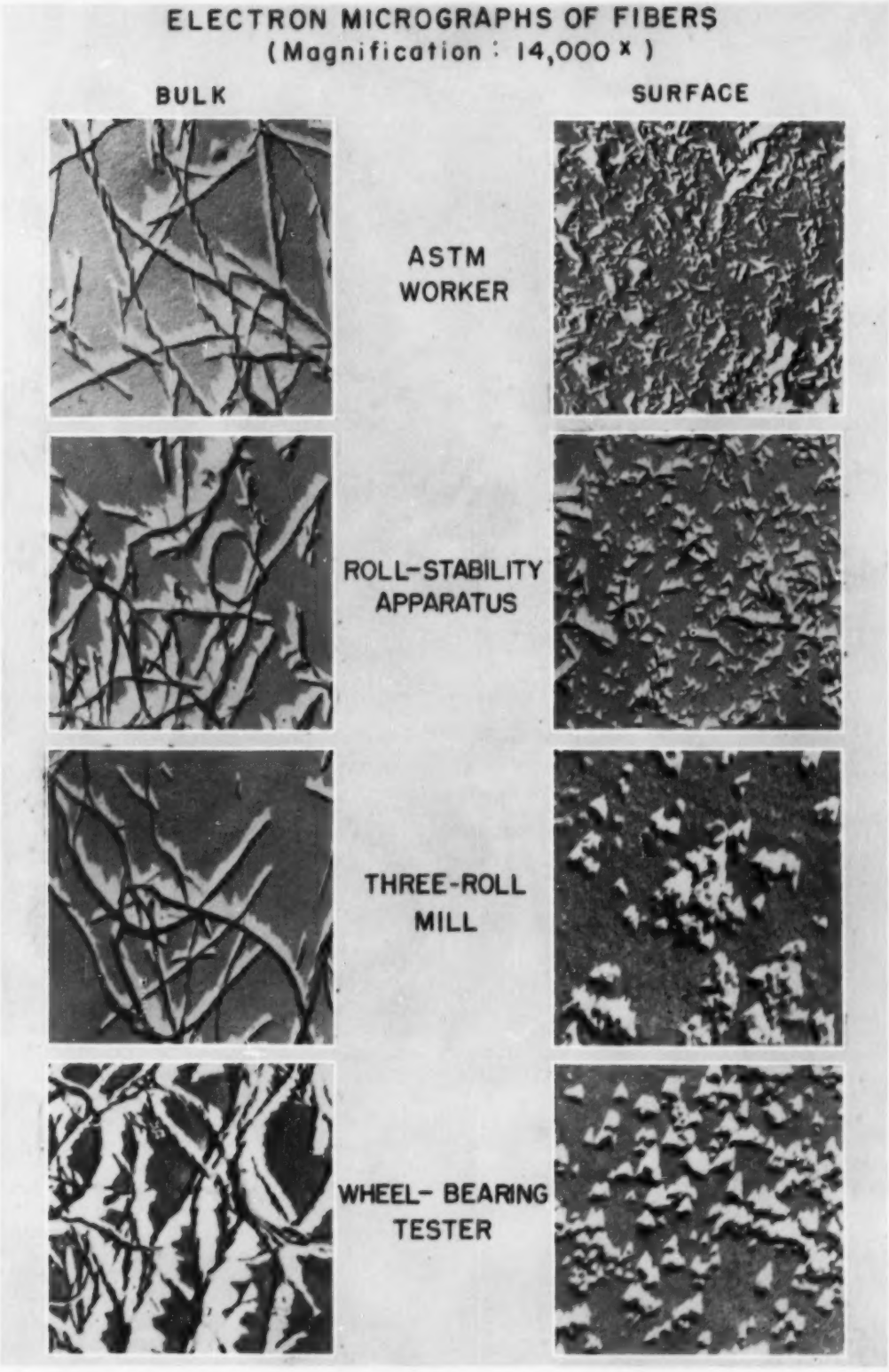
ELECTRON MICROGRAPHS OF FIBERS
(Magnification : 14,000 x)
BULK
SURFACE
ASTM WORKER
ROLL-STABILITY APPARATUS
THREE-ROLL MILL
WHEEL- BEARING TESTER

Figure 3

DISCUSSION

Symposium Papers Presented in Section III:

Technical Considerations of Mechanical Stability

By B. B. FARRINGTON
California Research Corporation

Presented at the
AMERICAN SOCIETY FOR TESTING MATERIALS
Committee D-2 on Petroleum Products and Lubricants
Houston, Texas
February 16, 1955

The papers that we have just heard have been presented under the heading of Technical Considerations of Mechanical Stability, and I suspect that this generously inclusive title was not unpremeditated. Indeed, the papers include so many technical considerations that I am sure they have been as stimulating and suggestive to you gentlemen as they have been to me. The quality of the papers reflects the thought which has been put into their preparation, and all of the authors deserve our unstinted praise for their careful work.

My discussion of these papers will, of course, be based on my personal viewpoint and experience and will, therefore, be more or less biased; but points of interest to me in the papers, in the order of their presentation, were as follows.

Mr. Zeiler in his paper has taken a broad view of mechanical stability and has included, besides the shear breakdown in the ASTM Worker and Roller Testers, the separation under pressure of oil from greases, and the pumping of grease through long pipelines. Because the performance of greases in industrial equipment and bearings is of vital importance to plant lubrication engineers, Mr. Zeiler's company has chosen certain simple laboratory tests, each of which they feel duplicates in some essential manner a part of the total action taking place in the equipment. Experience has, no doubt, convinced them that the final selection of tests does actually reflect the functional performance requirements of the equipment to be lubricated. This points up the fact that shear stability is only one of several performance characteristics which a grease must possess. In fact, it is probably quite necessary for a grease to have a certain amount of mechanical instability in order to lubricate satisfactorily. For example, Grease No. 13 was reported in the paper to be quite stable in both the ASTM Grease Worker and Roller Tests; yet this lubricant was classed as unsatisfactory. Greases considered satisfactory gave results in the Grease Worker from 8.1% hardening to 14.3% softening and in the Roller Test, from 3.1% hardening to 44.1% softening. The Roller Test at four hours is more severe than the ASTM Worker Test at 100,000 strokes (27.8 hours), and greases which hardened in the Grease

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Worker Test no doubt did so in the Roller Test but progressed through this stage at an early period. This points up the desirability of knowing the whole consistency-time curve for various shear rates, for various functional operations may require that the mechanical stability of a grease be set within limits. In the case in which the grease stiffened during a test, this may have been due to (1) the splitting of large thickener particles, thus adding more effective thickener at the same time that the smaller thickener particles were being disintegrated, or (2) alignment of thickener fibers (with consequent larger contact areas) followed by adhesion of fibers and rapid setting up of the grease on standing.

In the paper by Mr. Zweifel and Mr. Bane, shear stability of the greases was measured by the ASTM Worker and the Roller Tester, the former being operated for 100,000 strokes (27.8 hours) and the Roller Tester for one hour. The results from these two testers were thus brought somewhat into line, with the ASTM Worker Tester being slightly more severe. On the basis of equivalence of effect, the shearing action of the Roller Tester is about 25 times as severe as the standard ASTM Worker under these conditions. Because the effective shear rate of the ASTM Worker is estimated at 450 sec^{-1}, the effective shear rate of the Roller might be of the order of 10^4 sec^{-1}.

The stability of Grease "A" predicted from the results of these bench tests is borne out by the mechanical stability in railroad bearing service. Grease "B" broke down in the bench tests and also in the laboratory railroad bearing test. Further correlation between bench tests and railroad service would be of great interest.

Mr. Jackson and Mr. Booser point out in their paper that mechanical stability is an important factor in grease life in electric motors and that the demands on this stability vary with the type of bearing. They state that serious discrepencies result from the extrapolation of ASTM Worker or Roll Tester data to bearing performance. Although open bearing life is reported to correlate with ASTM and Roller tests, sealed bearing life is somewhat adversely affected by mechanical stability in the Roller test. This again accents the multifunctional performance required of greases, mechanical stability being only one of the factors involved. Other properties affecting performance, either favorably or adversely, are channeling, retention, and adhesiveness.

Questions raised concern the micropenetration method used to measure the consistency of the greases before and after the Whip Test, the presence or absence of air in the whipped grease samples, and the original consistencies of Greases "M," "N," and "O" reported in Table II. A summary of the physical properties and analysis of the greases reported would add to the interpretation of the data submitted. For example, in Table II, Greases "I" and "L," having the lowest initial penetration, are among the first four greases from the standpoint of retention.

Overpacking of ball bearings in conventional life test equipment is suggested as a method for evaluating ball bearing grease stability. This is certainly true when considering high-speed ball bearings for electric motors, but because oxidation and frothing effects cannot be segregated and because of the complexity of ball bearings and the difficulty of standardization of test instruments, their use to measure mechanical stability might involve serious difficulties.

In the paper by Messrs. O'Halloran, Kolfenbach, and Leland, it is stated that "only the high shear tests correlate with penetration changes found in bearing service experience. Employing a test rig using a high-speed small bearing may provide the simplest laboratory method of obtaining the necessary shear rates." Again, the use of high shear rates is certainly desirable, but in our opinion the ball or roller bearing would have to be simplified considerably, moving parts reduced in number and positive mixing of all of the grease assured, before a reproducible test method could be developed. The novel use by the authors of a dial micrometer to measure the consistency of thin samples of grease may make practical the development of a small, simple, sleeve-bearing type of tester which would shear a small sample of grease continuously at high speed.

The consistency data in Table II and III show that the ASTM Worker Test, even with the fine-hole worker plate, does not produce consistency changes in a shear-unstable grease similar to those induced by high-speed ball bearings. This may be due to the insufficient localized heating of the grease in the ASTM Worker or to the preferential chopping up of the long sodium soap fibers without splitting of the larger soap particles and subsequent feed back of soap fibers. In the pump valve shear test the shear-sensitive sodium grease may have been locally heated or the soap fibers may have been oriented to increase the bulk strength of the soap fiber matrix and hence increased the consistency on standing or cooling.

Messrs. Leet, Brunstrum, and Barnes pointed out in their paper that "there may be large differences between bulk grease and grease closer to a moving metal surface." This is especially true in bearings in which part of the grease is used as a packing or seal, or in bearings in which recirculation of the grease is erratic. The sampling of such used grease then becomes a matter of considerable importance and a composite sample made up of random single samples taken from various parts of the bearing may give an entirely misleading picture of grease performance.

An interesting comment made is that the ASTM Worker, with fine hole disk, and the Roller Tester affect penetration and L/W ratio in the same manner; this is also evident from data presented in some of the other papers. From their Figure 1, the penetration and L/W data for both methods (at about 28 hours, the time required for 100,000 strokes of the ASTM Worker) are approximately the same; at least the mechanical breakdown is of the same magnitude in each case. Our rough estimates of shear rate for the various testers are as follows:

	Shear Rate, Sec^{-1}
ASTM Worker, Standard holes	450
ASTM Worker, 1/16 inch holes	5400
Roller Tester (75 gm, 180 rpm)	8000 (assuming ½ grease milled continuously and .01 mm thickness of film)

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7025 West 66th Place, Chicago 38, Illinois
Representative—T. E. Shine

M. W. Parsons—Plymouth, Inc.
59 Beekman St., New York City 38, New York
Representative—Herbert Bye

Synthetic Products Company
1636 Wayside Rd., Cleveland 12, Ohio
Representative—Garry B. Curtiss

Swift & Company
165th & Indianapolis Blvd., Hammond, Ind.
Representative—F. H. Beneker

Vegetable Oil Products Co., Inc.
Vopcolene Division
5568 East 61st Street, Los Angeles 22, Calif.
Representative—C. F. Williams

Witco Chemical Company
75 East Wacker Drive, Chicago 1, Illinois
Representative—E. F. Wagner

TECHNICAL AND RESEARCH ORGANIZATIONS

Institut Francais du Petrole
CMrR—Courtel, 4 Place Bir Hackeim
Rueil—Malmaison (S. et Oise) France

Les Laboratoires de Recherches Purfina
31 rue de la Loi, Bruxelles, Belgium
Representative—R. Gillerot

Midwest Research Institute
425 Volker, Kansas City 10, Missouri
Representative—Dr. M. H. Thornton

National Rosin Oil Products, Inc.
1270 Ave. of the Americas, N.Y. City 20, N.Y.
Representative—Richard Bender

Petroleum Educational Institute
9020 Melrose Avenue, Los Angeles 46, Calif.
Representative—G. A. Zamboni

Phoenix Chemical Laboratory, Inc.
3953 W. Shakespeare Ave., Chicago 47, Ill.
Representative—Mrs. G. A. Krawetz

Products Development Laboratory
1 Market St.
West Warwick, Rhode Island

The effect of the three-roll mill seems to be much milder, probably because of the relatively short time the bulk of the grease was subjected to shearing action. The results may also indicate that in the roll mill some of the grease is slipping through the rolls unmilled.

The correlation of L/W with penetration of the grease is of considerable interest, and the electron microscope analysis aids greatly in determining the kind of mechanical breakdown taking place. That the grease on the metal surfaces is often in a state quite different from that in the bulk of the grease is worth stressing. This emphasizes the importance of the degree of circulation of grease in the bearing and bearing housing on the mechanical stability of the bulk grease.

We may conclude that simple bench tests, such as the ASTM Worker and the Roller Test, are useful tools for analyzing the shear stability phases of the total mechanical stability of greases under controlled but uncomplicated conditions. But they should not be interpreted as performance tests. An extension of these bench tests to higher shear rates by means of a simple, rapid test which would not require much grease and which would involve a temperature control appears to be a logical projection of the presently reported work. Such equipment would approach, at least in degree, the fast moving bearings of modern industrial equipment.

Patents and Developments

Greases Containing Oxonated Soaps

Lubricating grease compositions having outstanding structure stability are said to be prepared by thickening a lubricating oil base to a grease consistency with a metal salt of the product formed by reacting oleic acid or ester with carbon monoxide and hydrogen under high pressure and temperature in presence of a cobalt catalyst. In U.S. Patent 2,719,124 issued to Esso Research & Engineering Company, there is disclosed the method of oxonating a compound such as butyl oleate, and converting the butyl hydroxymethyl oleate to a lithium soap thickener.

The following example illustrates the steps involved:

A stainless steel bomb was charged with 5.2 moles of n-butyl oleate and 0.2 weight per cent of cobalt oleate, percentage being based on the weight of the n-butyl oleate. The bomb was then pressurized to 3500 pounds per square inch with a mixture of equimolar proportions of carbon monoxide and hydrogen. The oxonation reaction was carried out at 175°-185°C. for a period of five hours.

The oxonated product was then hydrogenated at 180°C. under a hydrogen pressure of 3000 pounds per square inch over a period of 16 hours.

The product was then isolated by dissolving it in petroleum ether and washing, first with dilute hydrochloric acid to remove the catalyst, and finally with water to remove the hydrochloric acid. The extract was then dried over sodium sulfate. On removal of the solvent at 100°C. under 2mm. pressure, the oxonated product was obtained as a viscous light colored oil. It proved to have a saponification number of 169.12 mg. KOH/gm., an acetyl number of 58.2 mg. KOH/gm., and an acid number of 4.06 mg. KOH/gm. Without any additional purification the product was used for the preparation of novel lubricating greases as set out below.

500 grams of the oxonated butyl ester was converted to the lithium soap of oxonated oleic acid by boiling with an aqueous solution of 65.5 grams of lithium hydroxide monohydrate, a slight excess over the theoretical amount required. This aqueous mass was then dried in a vacuum oven under reduced pressure to remove butyl alcohol liberated.

50 grams of the soap so prepared was then mixed with 50 grams of lithium stearate and the mixture added to 890 grams of a mineral lubricating oil having a viscosity at 210°F. of 40 SUS in a small experimental fire-heated grease kettle. The total mixture was then heated to 400°F. with agitation. There was then added 10 grams of phenyl alpha naphthylamine as an antioxidant, and the grease was allowed to cool in 1 inch layers in a cooling pan.

The grease, on cooling, formed a very hard, transparent cake which showed no oil separation. The cake was returned to the kettle, worked to a plastic mass, passed through a homogenizer, and then filtered.

Standard ASTM inspections on the grease composition prepared as described above are set out below.

Dropping point (°F.) 350
Penetrations (77°F., mm/10) unworked 315
Worked (60 strokes)[a] 320
Worked (100,000 strokes)[a] 375
Water solubility (210°F.)—Did not dissolve or emulsify in boiling water
A.F.B.M.A. test[b]: 1st test 80°F.; 2nd test 220°F.; 3rd test 250°F.—Bearings well lubricated. Grease does not tend to throw out of bearings, become fibrous or thin out sufficiently to leak through bearing seals.

[a]Fine Hole worked plate 270 1/16" holes.

[b]Anti-Friction Bearing Manufacturers Association Test. A No. 204 ball bearing is packed with the grease to be tested and run for 1 hour at a rate of 3600 R.P.M. at 3 test temperatures. The bearing lubricant is examined at the end of each test for consistency and leakage.

Complex Soap-Salt Thickened Grease

The thickening of lubricating oils with complex salt-soap thickeners in lieu of the conventional simple soaps of higher fatty acids was suggested in U.S. Patent 2,487,-080, discussed some time ago in this column. Short fiber, high temperature soda base greases were prepared by adding to a lubricating oil some 30-60% by weight of conventional high molecular weight fatty acid soap in combination with an alkali metal salt of formic, acetic, lactic, and similar low molecular weight carboxylic acids used in the proportion of 0.1-10% of the entire grease composition.

Other patents covering various features of such grease compositions are 2,417,428-33 and 2,516,136. In the recently issued patent 2,719,122, Esso Research & Development Company utilizes a combination of a monovalent metal and an alkaline earth metal salt for such combination.

In this latter patent, the monovalent metal soap (e.g. lithium) of the higher fatty acids is either performed and added to the oil as a dry powder, or it is formed in situ in mineral oil and completely dehydrated before the low molecular weight salt is added, also as a dry powder. A concentrate preferably is formed first, being cut back later by working in additional oil. After the first concentrate is prepared, enough oil should be added to permit complete dispersion of the solids (soap and salt) when heated.

The temperature of the mass, after addition of oil, is raised to such a point that the grease is completely melted or the crystal structure of the soap or complex is fully disrupted. As the mixture is cooled, a stable grease structure is established, apparently by crystallization of the complex thickener in the oil. This thickener, formed according to the process of the patent is claimed to impart to the grease properties which have not been attained and which would not be expected from a knowledge of properties of the separate constituents. By the anhydrous

method of soap-salt dispersion, the base exchange of soaps is prevented. The formation of high molecular weight soaps of the divalent metal and of low molecular weight salts of the monovalent metal is effectively inhibited. Hence objectionable side reactions do not occur. The combination product has substantially greater thickening power and superior water resistance. It shows superior oxidation inhibition with moderate amounts of conventional inhibitors. The resulting grease shows excellent mechanical stability over a wide range of operating temperatures.

An example of the preparation of a grease according to the latter patent is given as follows:

A stiff grease or soap concentrate was prepared using 20% by weight of fatty acid. In lieu of stearic acid, which is often preferred for greases of high quality, the substantially saturated hydrogenated fish oil acids of average chain length of about C_{18}, sold commercially under the trade names "Hydrofol Acids 51" or "Hydrofol Acids 54," may be used. These are quite fully equivalent to stearic acid. In this example "Hydrofol Acids 54" were neutralized with 3.3% by weight of lithium hydroxide monohydrate. The soap was prepared in situ and the grease dehydrated. Then 5% of dry calcium acetate which had been previously prepared was added, plus 1% by weight of a phenyl naphthylamine, specifically phenyl-alphanapthylamine. Other oxidation inhibitors may be used quite satisfactorily. In some cases they may be omitted, e.g., where the grease is frequently or continuously replaced in service. The remainder of the composition consisted of 70.7% of a mineral base lubricating oil having a viscosity of about 55 S.S.U. at 210°F. The grade or viscosity of the oil may be varied, of course, depending upon the type of lubrication needed.

The following procedure was followed in detail. The "Hydrofol Acid 54," and about one-third of the mineral oil were charged to a fire heated kettle and warmed to 150°F., to melt the acid and dissolve it in the mineral oil. Thereafter, the lithium hydroxide was added in an aqueous solution to neutralize the fatty acids. Soap was formed and the resulting concentrate in oil was dehydrated by heating it to a temperature of 275° to 300°F. Thereafter the previously prepared calcium acetate in the form of a dry powder was added. The mass was heated further to a temperature of 470°F. During this heating period the additional mineral oil was added gradually, while stirring was continued. Thereafter the grease was allowed to cool to below 250°F. with continued stirring.

The grease formed as described above, contained about 27% of thickener. It was a hard, smooth, uniform cake having a worked penetration (60 strokes with the standard ASTM ¼" hole worker plate) of 85 mm./10. The product had a free akalinity of 0.29%, calculated as sodium hydroxide, and a dropping point of over 420°F. It will be noted that this grease had a very hard consistency in proportion to its soap content, as compared with conventional greases. It was thereafter diluted, or cut back, by stirring additional mineral oil into the grease until the over-all soap-salt or complex thickener content was about 6% by weight. The cut-back or diluted grease product was then passed through a homogenizing apparatus under high shear conditions and tested for characteristic properties. It had an unworked penetration of 320 mm./10. Its worked penetration, with a standard ASTM grease worker operated for 60 strokes with a ¼" hole plate, was 348 mm./10. Its dropping point was 321°F.

The product also was tested for oxidation stability. In the Norma-Hoffman bomb oxidation test, where a sample of grease is placed under 110 p.s.i. initial pressure of oxygen at 210°F., the product of Example 1 showed more than 524 hours to a 5 p.s.i. drop in pressure. This is considered excellent performance. Oil separation in the 60 mesh cone test was only 2.0% after 50 hours storage at 210°F., which is quite outstanding. Structural stability was shown by working the product 100,000 strokes at 77°F., in the standard churn type ASTM grease worker, equipped with the fine hole worker plate (325 holes of 1/16 inch diameter). The product, which had an unworked penetration of 320 mm./10, increased in penetration only to 355 mm./10 in this severe test. It was insoluble in boiling water.

Hydrocarbon Oil Thickeners

Several patents were issued recently disclosing various soaps for use as thickeners for gasoline in the preparation of jellied gasoline for flame throwers and fire bombs. Since they also have potential use in lubricating greases, they are being mentioned here without much comment.

U. S. Patent 2,718,462, issued to Leonard Cohen, covers the use of soaps of iso-octoic acids obtained by oxidation of iso-octyl alcohols produced by the oxo-reaction (described in patent 2,553,364).

In U. S. Patent 2,719,782, there is described the formation of gels obtained by use of lanosterol as a thickener, Lanosterol is prepared by saponifying wool grease with sodium hydroxide, thereafter removing the lanolin acids as the insoluble calcium salt and removing the lanolin alcohols by a suitable solvent such as acetone. The lanosterol is obtained from the lanolin alcohol filtrate by precipitation with acetone and methanol.

Mighty Mouse, Space Cadet

A huge oil-based plastic balloon carrying 192 mice was recently sent more than 20 miles up to help scientists determine whether cosmic rays will be harmful to human beings traveling through the upper stratosphere in the world of tomorrow. The test balloon, which rose to a height of 115,000 feet was tracked by airplane and radio-guided truck until its descent 26 hours later. The mice, all alive and comfortable, were sent to university and government laboratories where they are currently being tested for possible reactions. The use of petroleum-derived plastics in test balloons is one of the latest applications of oil products in scientific research.

Progress

Three hundred gallons of jet fuel are required to taxi a current jet bomber from the warm-up ramp to the end of a runway for take-off, usually a distance of about one and one-half miles.

PETRONATE

(Reg. U. S. Pat. Office)

. . . the oil-soluble petroleum sulfonate for all four major functions . . .

- **A** Emulsification and Dispersion of Liquids
- **B** Dispersion and Wetting of Solids
- **C** Wetting and Dispersion of Liquid-Solid Systems
- **D** Inhibition of Rust and Corrosion

PETRONATE is the general trade name given by Sonneborn to its various types and grades of oil-soluble petroleum sulfonates.

The chart suggests the broad range of uses for this material. A laboratory sample of PETRONATE will help you determine how its many advantages can be put to efficient use in your manufacturing processes.

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1. Insecticide Emulsions	Emulsifying Agent for Toxicant	Spreading Agent
2. Textile Oils	Emulsifying Agent for Textile Processing Oils	Wetting and Dispersing Agent for Textile Fibers
3. Leather Oils	Emulsifying Agent for Leather Processing Oils	Wetting and Dispersing Agent for Leathers
DISPERSION AND WETTING OF SOLIDS		
4. Rubber Manufacture	Thermo Plasticizing Agent	Increases Dispersibility of Filler
5. Fuel Oil	Keeps Sludge in Suspension	Prevents Segregation of Moisture
6. Printing Ink Manufacture	Aids dispersion of pigment	Reduces Viscosity of Ink
7. Ore Flotation	Flotation Reagent	Selective Wetting Agent
8. Additives for Lube Oil	Acts as Detergent	Inhibits Bearing Corrosion
WETTING AND DISPERSION OF LIQUID-SOLID SYSTEMS		
9. Crude Oil Emulsion Splitting	Reverting Agent for Water-in-Oil Emulsions	Aids in Wetting out Salts and Solids
10. Emulsifiable Solvent Cleaners	Dispersing Agent for Oil and Grease Deposits	Acts as Emulsifying Agent
11. Dry Cleaning Compounds	Linking agent for Water and Solvent	Loosens Dirt Absorbed by Fabric
12. Fat Splitting Process	Dispersing Agent for Solid Fats	Acts as Wetting Agent
INHIBITION OF RUST AND CORROSION		
13. Corrosion Preventive Compounds	Rust and Corrosion Inhibiting Agent	Acts as Moisture Barrier
14. Anti-Freeze Solutions	Rust and Corrosion Inhibiting Agent	Aids in Dispersion of Scale
15. Soluble Cutting Oils	Emulsifying Agent for Mineral Oil	Rust Inhibitor

L. SONNEBORN SONS, INC.

New York 10, N. Y.

White Oil and Petrolatum Division, L. SONNEBORN SONS, INC.
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Industry NEWS

Monsanto Chemical Manufactures New Resin

Bisphenol A, an intermediate in the manufacture of epoxy resins, now is available in commercial quantities from Monsanto Chemical Campany's Organic Chemicals Division.

A full-scale plant for production of the poly-functional phenol was completed and put into operation by the company at St. Louis early in December.

A. Dave Evans, manager of resin materials sales for the division, said that process refinements incorporated into the new plant for bisphenol A have resulted in an exceptionally high-purity compound with excellent heat stability.

The product represents a major addition to Monsanto's fast-growing line of resin intermediates, Evans said. Long a ranking producer of maleic and phthalic anhydrides, the company has added adipic and fumaric acids to its catalog within the past year or so and has dibutyl fumarate and dibutyl maleate in advanced developmental stages.

With bisphenol A, Monsanto will serve the rapidly expanding market for epoxy resins. A big use for these resins is in the manufacture of surface coatings with outstanding durability and moisture and alkali resistance. They also go into structural laminates and into high-strength adhesives, especially for metal-to-metal bonding.

Plastic stamping dies made of epoxy resins are rapidly gaining favor for metal forming in the automotive and aircraft industries because of their ease of manufacture, light weight and economy.

New Gulf High Powered Distillation Device

Gulf Oil laboratories have found a way to "out-distill" the highest powered, modern research stills—and their new technique may bring untold benefits to the users of chemical and petroleum products.

The method, called gas-liquid partition chromatography, quickly separates gases and liquids whose boiling points are so close that the most elaborate present-day distilling columns either cannot take them apart at all, or require weeks to do so.

It also separates materials in quantities too small for distillation, permitting analysis where only traces are available and conserving costly research materials. In fact, a hypodermic needle is used to feed in the samples.

The apparatus used is a so-called chromatographic tube, simply a long thin tube filled with a granular powder which laboratory technicians coat with an oily substance. The tube is maintained at a constant temperature in a range up to 300° F.

When a fluid to be studied is injected, part of it goes into solution with the oily matter on the grains and the remainder becomes a gas in the spaces between the grains. A "carrier gas" is next introduced to force the gas in the spaces to move forward. Additional matter then comes out of solution into the voids between the grains, and is in turn moved forward by "carrier gas."

This process goes on continuously while the flow of "carrier gas" is maintained. It results in different components of the material under study moving down the tube at different rates, because each displays a different equilibrium between its soluble phase in the oily material and its gaseous phase in the spaces between grains.

As each component emerges from the end of the tube, it is detected by a conventional thermal conductivity cell and identified on the basis of its transit time through the tube.

The key to this new technique is the fact that, under the conditions described, the various compounds in a mixture can be made to move forward in a tube at different speeds and so can be easily separated at the end. Its significance lies in opening the door to the more exact knowledge of materials needed for producing higher effiency oils, gasolines, chemicals and plastics in the future. Further progress in these fields requires analysis of compounds to increasingly finer degrees.

Gas-liquid partition chromatography is based on a phenomenon in physical chemistry which has only recently been introduced to practical use by English scientists.

Learning of the work in that country in 1954, Gulf scientists instituted intensive research for applying it to the analysis of industrial petroleum and chemical materials. Successful results were reported to the scientific world at the 1955 Pittsburgh Conference on Analytical Chemistry and Applied Spectroscopy.

By breaking through the limits of distillation, the new technique is described as one of the most basic advances in separating fluids since man learned to boil off alcohol. The new type of chromatography is to the distillation column, what the column was to the primitive still.

To make the method generally available for laboratory research, Gulf has made arrangements whereby Fisher Scientific Co., Pittsburgh, Pa., will make a commercial Gas-Liquid Partition Chromatography unit. Production is now being launched, and data on the new instrument is available from Fisher.

American Potash Issues Bulletin on "Trona"

An informational bulletin on "Trona" lithium hydroxide has been issued by American Potash & Chemical Corporation for use in such industries as petroleum, storage battery manufacturing, lithium salt production, industrial plants needing an absorbent for gases in their production processes, and other applications.

The pamphlet provides information on potential uses, results of laboratory tests on lithium base greases and other material.

In addition, the bulletin contains information on the new San Antonio lithium hydroxide plant of American Lithium Chemicals, Inc., a subsidiary of American Potash & Chemical Corporation.

Copies of the informational folder can be obtained by writing to American Potash & Chemical Corporation, 3030 West Sixth Street, Los Angeles 54, Calif.

Witco Has New Bulletin On Metallic Stearates

A new and comprehensive 36-page bulletin outlining the properties and uses of metallic stearates has been published by Witco Chemical Co., for the information of purchasing, technical and executive personnel of 20 industries.

Especially designed for readability, the bulletin as prepared by Witco Technical Service Laboratory lists the composition of 46 metallic stearates, shows graphically the industries in which they are used and presents an analysis of recommended applications. Other helpful data include an explanation of Witco's analytical procedures, government specifications for metallic stearates, shipping information and a guide to other Witco products.

Industries mentioned are: cement, ceramics, cosmetics, explosives, greases, inks, lacquers, leather, metal working, oils, paints, paper, pharmaceuticals, plastics, petroleum, rubber, textiles, varnishes, water-proofing and waxes.

Copies of this bulletin, which is No. 55-2, "Stearates, Their Properties and Uses," are available upon letterhead request to Witco's headquarters, 122 East 42nd Street, New York 17, New York.

Service Station Training Kit Develops Personnel

A new service station training kit was released today by the Marketing Division of the American Petroleum Institute. Entitled "Service Station Personal Development Plans," it is designed for use by service station dealers in training their employees and by supplier salesmen in training dealers.

"This kit, which was prepared by our Personnel Training Committee as a service to oil marketers, is expected to be of particular help to dealers, jobbers, independent refiners, and commission wholesalers who are not in a position to build their own training programs," according to A. J. Rumoshosky, Marketing Division director.

"The kit coordinates the Committee's previous efforts into a compact training package for use by oil marketers and will be available for purchase at a price to recover only production and handling costs."

The complete kit comprises the following:

(a) Five copies of a personal development plan on service station fundamentals for use by the dealer in training his employees;

(b) Five copies of a personal development plan on service station management for use by the supplier salesman to train dealers;

(c) Five copies of a "progress check" folder which can be used to chart the trainee's progress;

(d) One copy each of the following Marketing Division booklets: *Know Your Motor Oil*, *How to Sell Motor Oil*, *Service Station Management Handbook*, and *Developing Your Men Builds Profits* (list price $1.90);

(e) An attractive file folder with a summary check list, *How to Develop Your Men* to coordinate the materials into a compact training package.

The training kit can be purchased from the Division of Marketing, American Petroleum Institute, 50 West 50th Street, New York 20. Since some marketers previously ordered copies of the booklets, the kit is available in three forms at the following prices:

(1) The complete kit including all four booklets, copies of the personal development plans on service station fundamentals and service station management and the "progress check" chart, together with the file folder—$1.75 each;

(2) The personal development kit, including all the foregoing items as in item (1) except the booklet, *Developing Your Men Builds Profits*—$1.25 each; and

(3) The kit without copies of any of the booklets, but including copies of the personal development plans on service station fundamentals and service station management and the "progress check" chart, together with the file folder—65c each.

Orders received will be filled promptly on receipt and shipped (cheapest way) prepaid, Rumoshosky said. Checks or money orders should be enclosed on orders for less than $5.00, he added.

Du Pont Increases Support to Education

A fund of more than $900,000 for grants to over 100 universities and colleges in its annual program of aid to education has been announced by the Du Pont Company. This support, which is for the next academic year, is a substantial increase over the $800,000 in gifts made for this year.

All of the increase and nearly half of the entire new program are for the improvement of teaching in colleges and universities and in high schools. The grants will support science and mathematics as well as other subjects.

The growth as well as the change in emphasis in the company's effort reflects the changing needs of the schools. At the same time, grants for fellowships in science, which once made up the entire program, and for fundamental research are being continued.

"In the face of increasing student population at all levels, a paramount problem is to maintain the quality of teaching and at the same time develop enough teachers," Crawford H. Greenewalt, president of the Du Pont Company, said. "We hope our program will encourage more young men and women to go into teaching.

"In large part our grants are intended to advance the teaching of science and mathematics. These subjects are a vital part of liberal arts education as well as fundamental to the education of scientists and engineers. Moreover, the laboratory sciences are the most expensive to teach of all the basic courses in the colleges and universities."

The fund for aid to teaching totals $445,000, including $200,000 to aid undergraduate teaching in 50 privately supported colleges. Of this amount, $125,000 is for advancing the teaching of chemistry, supplemented by $75,000 to strengthen the teaching of other subjects important in the education of scientists and engineers. The grants for teaching chemistry have been in effect this year and are being renewed for next year. The supplementary grants are being given for the first time.

The company's program for the advanced training of high school teachers of science and mathematics is nearly doubled. Grants totaling $130,000 are provided for fellowships for active and prospective teachers for summer sessions and the next academic year. The company announced the award of 134 teachers' fellowships to eight institutions for the coming summer and 22 fellowships to nine institutions for the academic year.

Purpose of this is to help in-service teachers advance themselves and to encourage students in the universities to go into the teaching profession.

Du Pont has also expanded its grants for postgraduate teaching assistantships to $115,000. There are 30 of these grants, mostly in chemistry, and they are shared by 28 universities. Purpose is to improve instruction in the universities and to encourage postgraduate students to enter teaching careers.

Under its longer standing plans, the company is granting $270,000 to universities for fundamental research and $190,000 for postgraduate fellowships in science and engineering.

Included in the authorization for research are grants-in-aid of $15,000 each to ten universities and $10,000 each to seven others.

There are also summer research grants of $1,500 each to 20 other universities. These are to enable younger staff members of university chemistry departments to undertake research of their own.

Shell Catalytic Cracking Unit Begins Operations

Shell Oil Company's newest and most advanced fluid catalytic cracking plant began operation in January at the new Shell refinery near Anacortes, Washington.

The cracking plant, designed for 23,000 barrels a day intake, employs a new technique to achieve a substantially greater high-octane gasoline yield than is obtained from more conventional cracking units, according to F. S. Clulow, manufacturing vice president.

Initial operation has exceeded design expectations, he disclosed.

The new technique employed in the cat cracking unit is the outgrowth of intensive process development work by Shell research and engineering personnel during the past several years. The company plans to release specific performance data and information on novel features this spring and will make its design available to other refiners through licensing arrangements.

Initial operation of the Anacortes refinery began last September with startup of the crude distillation and catalytic reforming units. Operation of the catalytic cracking facilities marks the completion of the refinery, which is designed to process 50,000 barrels of crude oil a day.

PEOPLE in the Industry

JOHN J. FERRIE

DONALD L. ESMAY

RONALD L. LARSEN

Warren Appoints Ferrie In New Jersey

The Warren Refining & Chemical Company, Cleveland, has announced the appointment of John J. Ferrie as sales representative for its lubricating division in northern New Jersey. A native of Edgewater, N. J., Ferrie is 27 and has worked in the lubrication field for the past seven years. He will make his headquarters at the Warren warehouse in North Bergen.

Esmay and Larsen to Lithium Corporation Staff

Donald L. Esmay and Ronald L. Larsen have joined the newly formed Department of Product Research and Development of Lithium Corporation of America, Inc., Minneapolis, it was announced by Walter M. Fenton, Director.

Esmay came to Lithium Corporation from the research laboratories of Standard Oil Company's Whiting, Indiana refinery where he worked in the field of hydrocarbon conversion reactions. He graduated from Dakota Wesleyan University, Mitchell, South Dakota, in 1946 and received his Ph. D. in Organic Chemistry from Iowa State College in 1951.

Larsen is a University of Minnesota graduate, class of 1955. He comes from the Uranium Division of Mallinckrodt Chemical Works, St. Louis, Missouri.

DEEP ROCK PROMOTES WILLIAMS AND WATTERS

Deep Rock Oil company is embarking in 1956 upon the largest advertising program of the company's modern history, and one result has been the elevation of two former advertising assistants to positions of new authority.

Deep Rock is the marketing subsidiary of Kerr-McGee Oil Industries, Inc., of Oklahoma City, its marketing facilities having been acquired in a merger this past spring.

Promoted were G. W. "Bill" Williams, named advertising manager, and Don Watters, new sales promotion manager. The advancements were announced by W. J. Fuchs, merchandising department manager.

Williams will handle advertising administration for Deep Rock and Kermac brands. Watters will coordinate all sales promotion plans with advertising plans. Their offices remain a part of the merchandising department.

Under Williams' direction will be planning of advertising in all media—newspapers, magazines, radio, television, signboards and others.

Watters will supervise point-of-sale, seasonal promotions, station dress, station supplies, displays and development of new product packages for the company.

Williams, a 33-year-old infantry veteran of World War II, is a native of Albion, Nebraska. He is a 1943 graduate of the University of Nebraska and a 1947 graduate of the University of Missouri school of journalism.

Before joining Deep Rock in 1952, Williams worked four years with Time, Inc., publishers of Life magazine, in St. Louis and New York, in advertising sales promotion and merchandising.

Williams served three and a half years as combat leader with the infantry during World War II, with the rank of captain. He was awarded three campaign ribbons, the Combat Infantry Badge and the Purple Heart for service on the Italian front.

Williams is a member of Kappa Tau Alpha, national scholastic honorary fraternity in the field of journalism, and of Alpha Delta Sigma, national advertising fraternity. He was awarded the University of Missouri chapter of Alpha Delta Sigma prize for 1947, awarded each year to an outstanding male student majoring in advertising.

He is a member of the Tulsa Advertising Federation.

Williams is married and the father of one child. His home address is 2128 Erin Place, Oklahoma City.

Don Watters is a native of Henryetta, Oklahoma. He is the son of Mrs. Edna C. Watters, 411 State Street, Henryetta.

Watters, 31, is a graduate of Oklahoma A&M college with majors in journalism and advertising. He attended the University of Pittsburgh for pilot's training during World War II.

A recipient of the Distinguished Flying Cross for achievement beyond the call of duty, Watters also was awarded the Air Medal with Oak Leaf Cluster. Watters flew with combat bomber crews over the Central Pacific, Japan and China Coast targets during World War II.

Before joining Deep Rock in 1952, Watters had been production manager of the creative division of McCormick Armstrong Company, Wichita, Kansas, from 1949 to 1951; and account executive for Watts-Payne Advertising Agency, Tulsa, 1951-52.

A member of Sigma Delta Chi, national honorary journalism fraternity, Watters is a member of the Tulsa Advertising Federation and the Tulsa Junior Chamber of Commerce. He attends the First Christian church.

New Coordinators Named By Gulf Oil Corporation

Four new Coordinators have been appointed by Gulf Oil Corporation to assist Senior Vice Presidents of the Corporation in carrying out their administrative functions.

Mr. R. A. Hunter has been named Coordinator, Marketing Department. As such, he will report directly to Senior Vice President H. G. Meador, Marketing, and work with him and the Vice Presidents of Domestic Marketing and Foreign Marketing in the formulation and coordination of policies, plans and programs, not only as they concern Gulf's marketing activities at home and abroad, but also in relation to the other departments of the company.

Mr. A. C. Rall and Mr. J. F. Tim, Jr. have been appointed Coordinators on the staff of W. L. Naylor, Senior Vice President, Financial. Messrs. Rall and Tim, reporting directly to Mr. Naylor, will assist in the formulation and coordination of policies, plans, and programs in the international financial activities of the Corporation and its subsidiaries and affiliates as they affect the Comptroller and Managers of the Tax, Credit and Budget Departments, including their relationships with other departments of the Corporation.

Dr. Hollis D. Hedberg has been named Coordinator and appointed to the Production Coordination Staff. He will report to R. O. Rhoades, Senior Vice President, Production, and maintain close relationship with the company's exploration activities in both the Eastern and Western Hemispheres, as carried out by the Production Department's several divisions. He will keep Mr. Rhoades constantly informed regarding the scope and status of Gulf's exploration efforts on a world-wide basis.

All four of the new Coordinators are veterans of long experience, not only with Gulf, but in their respective fields.

They will be located in the company's general offices in the Gulf Building, Pittsburgh.

Gulf had previously announced the appointment of Mr. E. J. Kirberg as Coordinator, Manufacturing Department.

Johnson Heads Kings Mountain Foote Plant

Appointment of Neil O. Johnson as plant manager of Foote Mineral Company's Kings Mountain, N. C., mining operation has been announced by Felix B. Shay, vice president of production. Effective January 1, 1956, Johnson will assume charge of the company's spodumene mine and ore processing plant.

A former Birmingham, Alabama resident, Johnson leaves the explosive department of E. I. DuPont de Nemours, of Wilmington, Delaware where he had served since 1939 as technical representative. In this capacity he acted as consultant and advisor on demolition and blasting problems in mine, quarry and contruction operations.

A World War II Major in the Corps of Engineers, Johnson served in Alaska on the famous Alcan highway project. Later he became a project officer on the Engineering Board of the Joint Army-Navy Board and served as consultant on advanced design equipment.

Johnson has had extensive mining experience, and was associated for a number of years with the Hog Mountain Gold Mining and Milling Company of Birmingham, Alabama. He has also served as an engineer on the staff of the Dorr Company, Inc. of New York, a consulting firm specializing on the erection and operation of chemical processing equipment.

He is a graduate of the Colorado School of Mines and received his degree as Engineer of Mines in 1933. He is a member of Tau Beta Pi scholastic honorary and Sigma Alpha Epsilon social fraternity.

The Kings Mountain plant which Johnson will head supplies lithium ore concentrates to Foote Mineral's lithium chemical processing operations at Sunbright, Virginia and Exton, Pa. It is the largest lithium ore processing operation in the world.

Acheson Appoints J. Wermuth Assistant to Treasurer And W. H. Leggett Sales Office Head

JOHN M. WERMUTH

WILLIAM H. LEGGETT

John M. Wermuth has been named Assistant to John C. Sprague, treasurer of Acheson Industries, Inc., Port Huron, Mich.

A graduate of the University of Rochester, Bachelor of Arts degree, Mr. Wermuth received a Masters degree in Business Administration in 1952 from the Harvard Graduate School of Business Administration.

Serving in the U.S. Navy from 1946 to 1948, he was stationed at the U.S. Naval Research Labs, Washington, D.C. and at the Submarine Base in New London, Conn.

Mr. Wermuth's business experience includes three years with Warner-Hudnut, Inc., New York, where he was Assistant to the Secretary.

While in New York, Mr. Wermuth was advisor to the Junior Achievement Club of New York. He is a member of the Harvard Business School Club, Psi Upsilon fraternity, Phi Beta Kappa and the N.Y. Credit & Financial Management Association.

A native of Rochester, N. Y., Mr. Wermuth and his wife, the former Marilyn McCuskey, have an infant son, Robert Andrew.

The appointment of William Howard Leggett as sales engineer has been announced by Acheson Colloids Company, Port Huron, Michigan.

Mr. Leggett will head the Rochester, New York, sales office of the company, covering upstate New York and replacing Edwin A. Lampman who retires in January, 1956, after serving 25 years with the company.

Last with J. R. Stewart Co., Inc., manufacturers' representatives, Mr. Leggett received his technical training at Rochester Institute of Technology, and is a member of the American Society of Tool Engineers.

Continental Can Appoints Dr. Paul Erlandson

Dr. Paul Erlandson, former chairman of the physics department and assistant vice president of Southwest Research Institute, San Antonio, Texas, has been named director of the department of physics of Continental Can Company's new Central Research and Engineering Division, according to Curtis E. Maier, general manager of the division, which will ultimately employ 75 professional scientists and 25 administrative personnel.

In his new position, Dr. Erlandson will head the company's experimental work on the application of the principles of physics to the high speed automatic equipment used in manufacturing and closing metal, paper, plastic and composite containers and closures, as well as to its future ionizing radiation sterilization program.

A graduate of the Massachusetts Institute of Technology and the University of Texas, where he received his Ph. D. degree, he is a member of the American Physical Society, the Institute of Radio Engineers, the Optical Society of America, and many other professional groups.

His experience in the fields of physics and electrical engineering has included work in acoustics, optics, electromechanics, nuclear resonance, electrostatics, transducer design, geophysics and industrial processing equipment.

During World War II, he was a project officer with the Navy Bureau of Ships, Research and Development Branch, Electronics Division, and represented the Bureau on committees of the N.R.D.C. and the Joint Chiefs of Staff.

Kerr-McGee Announces Public Relations Director

Ross W. Cummings, former WKY-TV newsman, has been named director of information and public relations for Kerr-McGee Oil Industries, Inc. In this capacity, he handles public relations as well as supervising publications and employee communications for the Kermac organization.

With WKY-TV news bureau his television name was Reed Connolly. Formerly managing editor of the Holdenville Daily News, Cummings earlier had worked as a member of the advertising staff of The Wewoka Times and as news broadcaster and announcer for radio station WBBZ in Ponca City.

Cummings attended the Ponca City public schools, Pembroke-Country Day School in Kansas City and the University of Oklahoma. He is married to the former Joy Elaine Phillips of Holdenville.

The Cummings and their two children, Roxanne, 4½ and Tom, 2½, make their home at 1323 N. W. 80th, Oklahoma City.

Meyer, Foote Chairman, Announces Retirement

H. C. Meyer, Chairman of the Board of Foote Mineral Company, has announced his retirement effective December 31, 1955. He will retire both as Chairman and as a board member after fifty years of service to the company.

In making the announcement, Mr. Meyer pointed out that he has passed the company's normal retirement age. At the request of the Board of Directors, he will, however, continue to assist the company in an advisory role, after his official retirement.

Mr. Meyer joined Foote Mineral Company in 1906, in the capacity of mineralogist. As an associate of Warren M. Foote, son of the company's founder, Mr. Meyer travelled extensively through the United States, Europe and South America collecting mineral specimens. He is today one of the country's leading authorities on commercial mineral deposits.

Serving in various capacities over the years, Mr. Meyer became president of the company in 1936, a position which he held until 1952 when he was elevated to Chairman of the Board.

During his years of service with Foote, the company rose from an obscure mineral specimen house to a major chemical producer. The company has pioneered numerous important developments in the rare element field. It was the first to produce commercial quantities of pure zirconium metal, a material important in many nuclear processes. Foote is today the foremost producer of lithium, also believed to have potential nuclear applications.

In his letter of resignation, Mr. Meyer states; "Although I am divesting myself of all executive and managerial responsibilities, I shall still have a keen, continuing interest in the welfare and growth of the Company. To do otherwise would be to repudiate the many warm friendships established through the years.

"I wish to thank the members of the Board for their sympathetic understanding of the motives which prompted my decision."

In accepting Mr. Meyer's resignation, the Board of Directors announced that the vacancies thus created would not be filled immediately.

API's President Porter Addresses Kansas Oil Men

Cooperation among all branches of America's petroleum industry for defense "against many insidious and ill-intentioned detractors" was asked by Frank M. Porter, president of the American Petroleum Institute, in addressing the Kansas Oil Men's Association.

"Let us not be so reckless in making charges against one another that we eventually become too preoccupied with defending ourselves against ourselves," Mr. Porter said.

"Certainly," Mr. Porter said, "one must admit that there are some abuses and unsound practices to be found today in . . . this highly competitive industry of ours . . . The producers, the refiners, and the transporters all have their complaints and each group is sincere in its belief that its difficulties are more critical than those of others. And yet the difficulties of each group all have one thing in common . . . the spirited competition which pervades the entire industry . . ."

To document his reference to the competitive nature of the oil industry, the API president pointed out that "recently, Fortune Magazine compiled a list of the 500 largest industrial corporations in the United States. In this list, there were 30 oil companies. No other industry was represented on this list by so many different corporations.

"That doesn't sound like monopoly," the speaker said.

The API president attributed internal recriminations to the fact that each segment of the industry must

keep up with demand and keep adequate supplies on hand for emergencies, while avoiding overloads on storage facilities.

"It doesn't take much of a petroleum economist to know that as the demand for petroleum products is brought into balance with supply, many of our intra-industry difficulties disappear," Mr. Porter said. He added that, if recent unusually cold weather continued, the already moderating "surplus problem" would disappear, and "ironically . . . tempers may flare again and controversies may reappear—but the cause would be tight supply, rather than a surplus."

"Anyone who reads the trade press these days must be conscious of the fact that there are many responsible oil men in management positions who are giving their attention to the current problems of the industry," the speaker said. "The struggle for customers and markets will continue—but I look for this competition to be more in keeping with business practices which are generally recognized to be sound and ethical."

The API president praised the Kansas group for their "clear-cut policies" on issues of national importance such as the depletion question and relief from federal control of interstate natural gas prices at the wellhead, as contemplated in the Harris Bill. Mr. Porter also commended the Association for its work in opposing compulsory "divorcement" of integrated companies from marketing operations, and for its cooperation with the Kansas Petroleum Industries Committee and the Oil Industry Information Committee.

"What I have said," Mr. Porter concluded, "is . . . in the nature of a plea to all oil men in all branches of the industry." If industry components spend their energies in charges and countercharges against one another, he said, "we will be unable to find either time or common ground to defend ourselves or our industry against many insidious and ill-intentioned detractors on the outside."

Dr. R. K. Gould New Editor of Lubrication Engineering

Dr. R. K. Gould is the newly appointed Editor of LUBRICATION ENGINEERING, the Journal of the American Society of Lubrication Engineers.

Dr. Gould is a graduate of Duke University (A.B. 1938; M.A. 1939; Ph.D. 1941), and has been with The Texas Company since 1941. He acquired a broad and varied background in the fields of petroleum processing and industrial lubrication, and is currently engaged in technical service activities on industrial lubricants.

Dr. Gould also serves as Editor of The Texas Company's well known monthly magazine, "LUBRICATION."

Climax Molybdenum's E. K. Leavenworth to Technical Post

Transfer of E. Kendrick Leavenworth to the technical processes and economic engineering staff of Climax Molybdenum Company has been announced by L. S. Deitz, Jr., manager of the department. Mr. Leavenworth is being transferred from the company's research laboratory at Detroit, Michigan, where he has held various supervisory positions since 1943.

A graduate of the Yale Sheffield Scientific School in 1928, Mr. Leavenworth was associated with his family's building construction company before joining Climax. While at the Detroit laboratory he served in the chemical and x-ray sections before developing equipment and techniques for the vacuum arc-cast melting of metallic molybdenum and its alloys and is a holder of patents covering this process. At the time of his transfer he was supervising developmental work on the use of molybdenum sulfide as a lubricant.

Mr. Leavenworth is a member of the American Society for Metals, the Society of Automotive Engineers and the American Radio Relay League. In his new capacity his headquarters will be in New York.

Deep Rock Appoints A. R. Gockel

A. R. Gockel has been named coordinator of sales administration and marketing research for Deep Rock Oil company. The move has been announced by F. C. Love, president of Deep Rock. The sales control department, under H. E. Burba, will report directly to Gockel, and all marketing research functions will be under Gockel's supervision. Gockel remains in charge of Deep Rock branded sales for the Arkansas-Tennessee-Mississippi area.

S. T. Lutz to Manage U. S. Steel's Kansas District

The appointment of Scott T. Lutz as manager of the Kansas district of U. S. Steel's Oil Well Supply Division was announced by Mark Barkhurst, Mid-Continent Area manager of the division. Mr. Lutz will headquarter at Wichita, Kansas.

Mr. Lutz joined "Oilwell" in 1937 at Hutchinson, Kansas. In 1938 he was transferred to Wichita, Kansas, and in 1941 was transferred to McPherson, Kansas, becoming "Oilwell" store manager at this location in August, 1942. Three months thereafter he was appointed manager of the division's store at Stafford, Kansas, and was located here until 1945, when he obtained a leave of absence to serve in the United States Army.

In November, 1945, Mr. Lutz returned to the employment of "Oilwell" as city representative at Wichita, where he was located prior to his present appointment. He is a native of Kansas.

Hurley Joins Foote Mineral As Traffic Manager

Frank E. Hurley has joined Foote Mineral Company, Philadelphia, Pa., as Traffic Manager effective December 9, 1955, and will be in charge of all domestic and foreign traffic. Mr. Hurley comes to Foote with a record of seven years experience in the field and before joining the company held a similar position with the St. Louis office of Keasbey & Mattison Company.

Hurley received his bachelors degree in economics in 1948 from the University of Pennsylvania. He received graduate training both at Penn and at the Academy of Advanced Traffic in Philadelphia.

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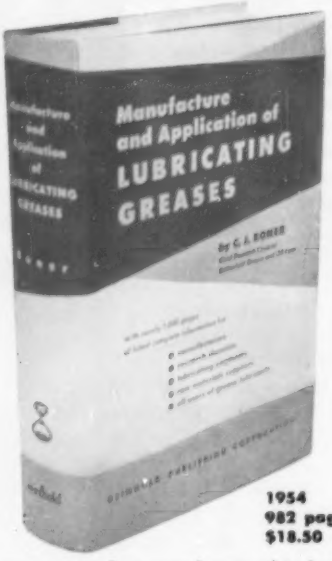

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FUTURE MEETINGS of the Industry

FEBRUARY, 1956

2-3 Western Petroleum Refiners Association (regional meeting), Shamrock Hilton Hotel, Houston, Texas.

5-10 American Society of Testing Materials (Committee D-2, Petroleum Products and Lubricants), Statler Hotel, Dallas, Texas.

9-10 Private Truck Council of America, Inc. (annual convention), Cleveland Hotel, Cleveland, Ohio.

22-23 Iowa Independent Oil Jobbers Association, Inc. (convention), Fort Des Moines Hotel, Des Moines, Ia.

24 Natural Gasoline Association of America (regional meeting), Lincoln Hotel, Odessa, Tex.

26-29 American Institute of Chemical Engineers, Statler Hotel, Los Angeles, Cal.

27-29 Missouri Petroleum Association (annual meeting), Chase Hotel, St. Louis, Mo.

28-29 American Petroleum Institute (Division of Marketing, Lubrication Committee), Sheraton Cadillac Hotel, Detroit, Mich.

MARCH, 1956

7-9 American Petroleum Institute (Division of Production, Southern District Meeting), Plaza Hotel, San Antonio, Tex.

12-16 National Assn. of Corrosion Engrs. (annual convention), Statler Hotel, New York, N.Y.

13-14 Illinois Petroleum Marketers Association (24th annual convention), Sherman Hotel, Chicago, Ill.

15-17 Texas Oil Jobbers Association, Statler Hilton Hotel, Dallas, Texas.

19-21 Western Petroleum Refiners Association (annual meeting), Plaza Hotel, San Antonio, Tex.

20-22 Ohio Petroleum Marketers Assn., Inc. (Spring convention & trade exposition), Deshler Hilton, Columbus, Ohio.

21-23 American Petroleum Institute (Division of Production, Southwestern District Meeting), Texas Hotel, Fort Worth, Tex.

30 Florida Petroleum Marketers Association (annual meeting), Geo. Washington Hotel, Jacksonville, Fla.

APRIL, 1956

2-4 American Institute of Electrical Engrs. (Southwest District No. 7), Dallas, Texas.

4-6 American Society of Lubrication Engineers (annual meeting), William Penn Hotel, Pittsburgh, Pa.

8-13 American Chemical Society, Dallas, Texas.

14-18 Petroleum Equipment Suppliers Association of America, Boca Raton Hotel, Boca Raton, Fla.

16-20 Greater New York Safety Council (annual convention and exposition), Statler Hotel, New York, N. Y.

18-20 National Petroleum Association (semiannual meeting), Cleveland Hotel, Cleveland, Ohio.

22-26 National Tank Truck Carriers, Inc., Shoreham Hotel, Washington, D. C.

29-May 1 Independent Petroleum Association of America (semiannual meeting), Statler Hotel, Los Angeles, Cal.

30-May 2 Chamber of Commerce of the United States (annual meeting), Washington, D. C.

30-May 4 American Petroleum Institute (safety and fire protection mid-year meeting), Warwick Hotel, Philadelphia, Pa.

MAY, 1956

13-15 Empire State Petroleum Association, Statler Hotel, Buffalo, N. Y.

13-15 Pennsylvania Petroleum Association, Bedford Springs Hotel, Bedford, Pa.

Continued on page 48

MAY, 1956

14-17 American Petroleum Institute (Division of Refining, 21st mid-year meeting), Sheraton Mount Royal Hotel, Montreal, Canada.

21-23 American Petroleum Institute (Division of Marketing, mid-year meeting), Atlanta Biltmore, Atlanta, Ga.

23-26 American Petroleum Institute (Division of Marketing, Lubrication Committee), Broadmoor, Colorado Springs, Colo.

JUNE, 1956

3-8 SAE Summer meeting, Chalfonte-Haddon Hall, Atlantic City, N. J.

4-8 National Fire Protection Assn. (60th annual meeting), Statler Hotel, Boston, Mass.

17-22 ASTM 59th Annual Meeting and 12th Apparatus Exhibit, Chalfonte-Haddon Hall, Atlantic City, N. J.

21-22 Western Petroleum Refiners Association (regional meeting), Broadview Hotel, Wichita, Kansas.

25-29 American Institute of Electrical Engrs. (1956 Summer & Pacific general), San Francisco, Calif.

SEPTEMBER, 1956

7-8 Desk & Derrick Club, New Orleans, La.

12-14 National Petroleum Association (annual meeting), Traymore Hotel, Atlantic City, N. J.

16-21 American Chemical Society (130th annual meeting), Atlantic City, N. J.

16-22 ASTM 2nd Pacific Area National Meeting and Apparatus Exhibit, Hotel Statler, Los Angeles, Calif.

19-21 National Industrial Conference Board (marketing meeting) Waldorf-Astoria Hotel, New York, N. Y.

20-21 Mid-Continent Oil & Gas Assn. (membership meeting La.-Ark. Division), Roosevelt Hotel, New Orleans, La.

OCTOBER, 1956

1-3 Texas Mid-Continent Oil & Gas Association (annual meeting), Rice Hotel, Houston, Texas.

1-5 American Institute of Electrical Engrs. (1956 Fall general), Morrison Hotel, Chicago, Ill.

14-20 American Petroleum Institute Oil Progress Week.

17-19 National Industrial Conference Board (atomic energy meeting), Waldorf-Astoria Hotel, New York, N. Y.

22-24 NLGI ANNUAL MEETING Edgewater Beach Hotel, Chicago, Ill.

29-30 Independent Petroleum Association of America (annual meeting) Statler Hotel, Dallas, Texas.

NOVEMBER, 1956

1-2 SAE National Diesel Engine Meeting, Drake Hotel, Chicago, Ill.

8-9 SAE National Fuels and Lubricants Meeting, The Mayo, Tulsa, Okla.

12-15 American Petroleum Institute (36th annual meeting), Conrad Hilton & Palmer House, Chicago, Ill.

26-30 National Exposition of Power and Mechanical Engineering (ASME), New Coliseum, New York, N. Y.

27-30 American Chemical Society (9th National Chemical Exposition), Cleveland, Ohio.

APRIL, 1957

16-18 National Petroleum Association, Cleveland, Ohio

JUNE, 1957

16-21 American Society for Testing Materials, Chalfonte-Haddon Hall, Atlantic City, N. J.

SEPTEMBER, 1957

11-13 National Petroleum Association, Atlantic City, N. J.

OCTOBER, 1957

28-30 NLGI ANNUAL MEETING Edgewater Beach Hotel, Chicago, Ill.

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JUNE, 1958

22-28 ASTM 61st Annual Meeting, Hotel Statler, Boston, Mass.

SEPTEMBER, 1958

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OCTOBER, 1958

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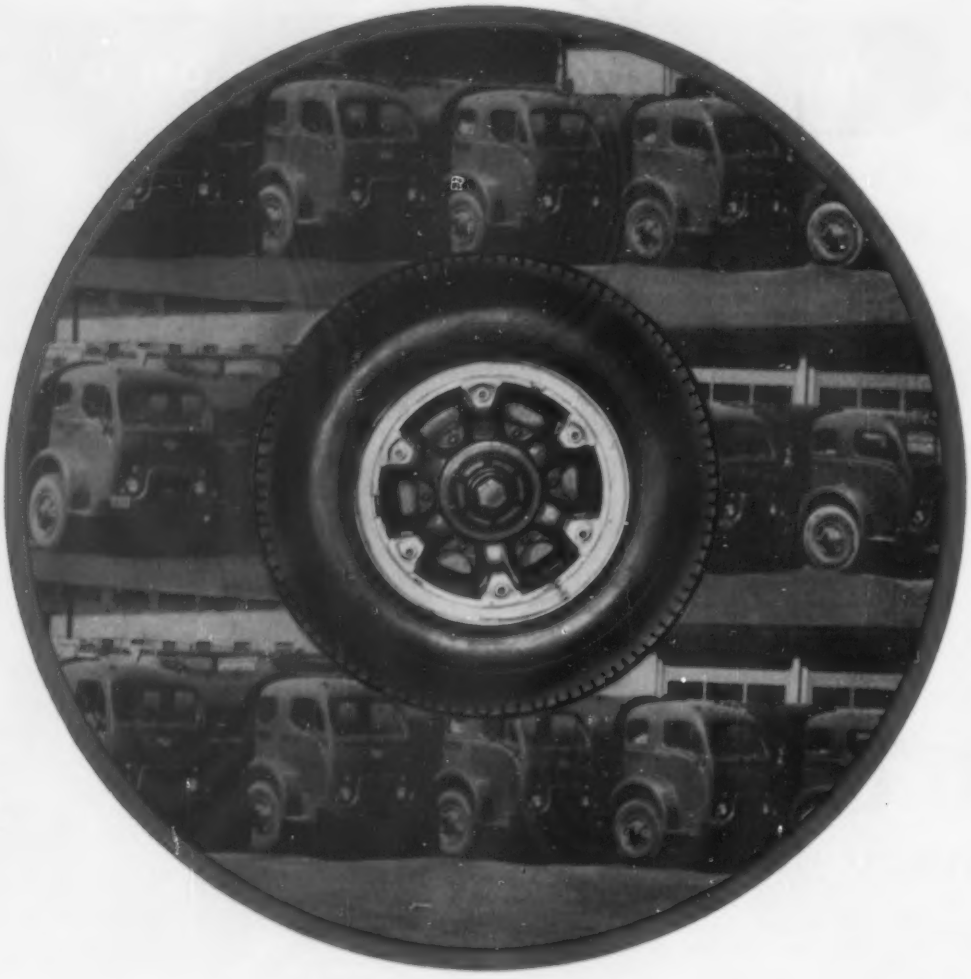

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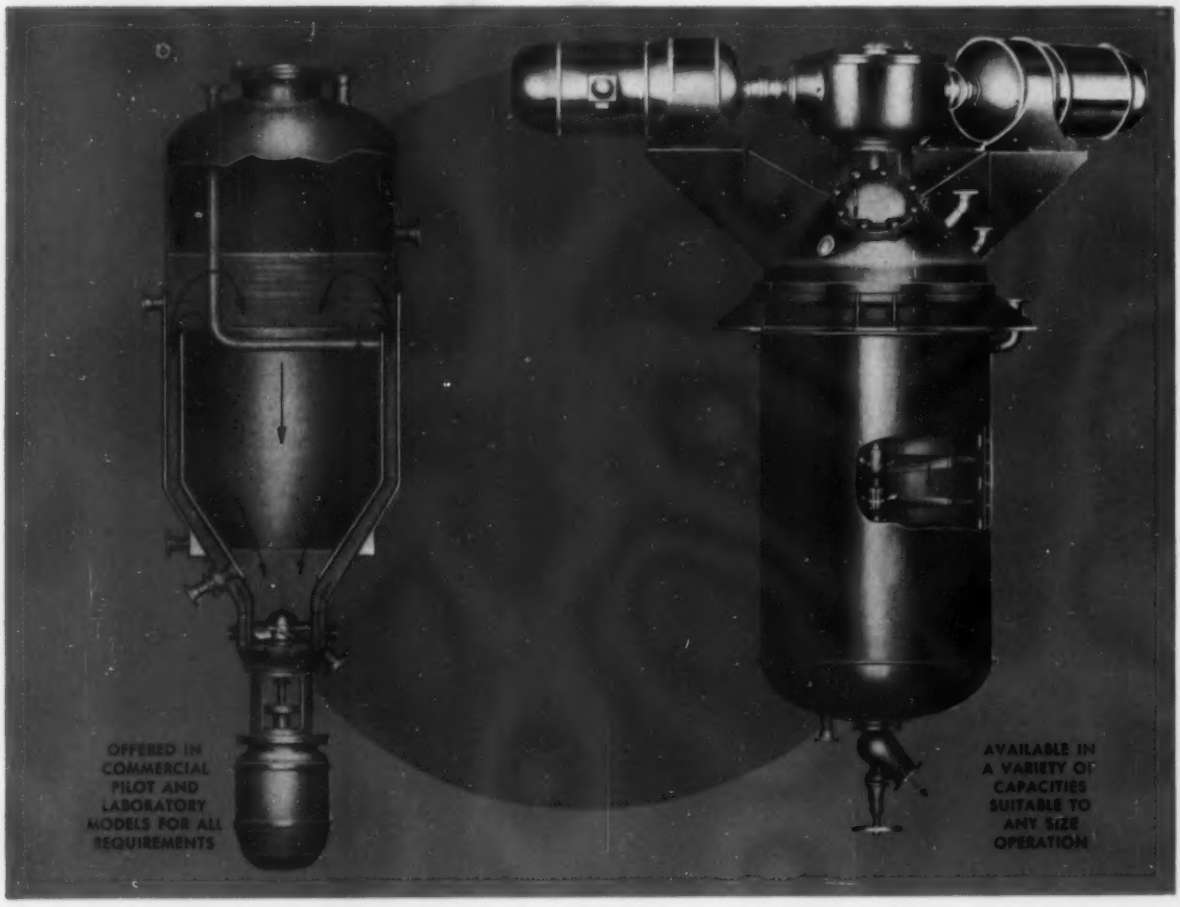

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